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ABSTRACT

This document is intended to help education and training institutions deliver the Machine Tool Advanced Skills Technology (MAST) curriculum to a variety of individuals and organizations. MAST consists of industry-specific skill standards and model curricula for 15 occupational specialty areas within the U.S. machine tool and metals-related industries. This volume provides the MAST standards and curriculum for the machinist specialty area. (A machinist is a person who is responsible for the planning, layout, set up, and operation of hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.) This volume is organized in the following sections: (1) a profile of Texas State Technical College, the development center that produced these standards and curriculum; (2) a machinist competency profile of job duties and tasks; (3) a machinist duty, task, and subtask outline; (4) a course curriculum outline, course descriptions, and a list of capital equipment needed; (5) a technical workplace competencies and course crosswalk; and (6) a Secretary's Commission on Achieving Necessary Skills (SCANS) proficiencies course crosswalk. Individual syllabi for the following courses are provided: Machine Tool Practices I-IV; Precision Tools and Measurements; Industrial Specifications and Safety; Survey of Welding Processes and Applications; Manufacturing Processes; Introduction to Computer Numerical Control (CNC); and Advanced CNC. Each course syllabus includes the following: course hours, course descriptions, prerequisites, required course materials, teaching and evaluation methods, lecture and laboratory outlines, course objectives for technical and SCANS competencies, and suggested references. Two appendixes contain industry competency profiles and a pilot program narrative. (KC)

ED 401 433

Machine Tool
Advanced
Skills
Technology

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COMMON GROUND:
TOWARD A STANDARDS-BASED TRAINING SYSTEM FOR THE U.S. MACHINE TOOL AND METAL RELATED INDUSTRIES

VOLUME 3

MACHINING

of
a 15 volume set of Skills Standards
and
Curriculum Training Materials for the
PRECISION MANUFACTURING INDUSTRY

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COMMUNITY COLLEGE

Texas State
Technical College
Waco

*M*achine Tool *A*dvanced *S*kills *T*echnology Program
MAST

VOLUME 3

-- MACHINING --

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This project was made possible by the cooperation and direct support of the following organizations:

- U.S. Department of Education, Office of Vocational & Adult Education
- MAST Consortia of Employers and Educators

MAST DEVELOPMENT CENTERS
Augusta Technical Institute - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Central Florida Community College - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High - Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MAST PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, National Tooling and Machine Association (NTMA)

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

This report is primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 3,000 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

This material may be found on the Internet at **http://machinetool.tstc.edu**

CATALOG OF 15 VOLUMES

VOLUME 1	EXECUTIVE SUMMARY STATEMENT OF THE PROBLEM MACHINE TOOL ADVANCED SKILLS TECHNOLOGY PROJECT PROJECT GOALS AND DELIVERABLES PROJECT METHODOLOGY PROJECT CONCLUSIONS AND RECOMMENDATIONS APPENDICES
VOLUME 2	CAREER DEVELOPMENT GENERAL EDUCATION REMEDIATION
VOLUME 3	MACHINING - CORE COURSES (MAC)
VOLUME 4	MANUFACTURING ENGINEERING TECHNOLOGY (MET)
VOLUME 5	MOLD MAKING (MLD)
VOLUME 6	WELDING (WLD)
VOLUME 7	INDUSTRIAL MAINTENANCE (IMM)
VOLUME 8	SHEET METAL (SML) AND COMPOSITES (COM)
VOLUME 9	TOOL AND DIE (TLD)
VOLUME 10	COMPUTER-AIDED DRAFTING AND DESIGN (CAD)
VOLUME 11	COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC (CNC)
VOLUME 12	INSTRUMENTATION (INT)
VOLUME 13	LASER MACHINING (LSR)
VOLUME 14	AUTOMATED EQUIPMENT TECHNOLOGY (CIM)
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VOLUME 3

MACHINING

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FOREWORD

After many interviews with practitioners from industry (see Appendix A), and discussions with educators, managers, supervisors, and others involved with machine-related occupations and specifically machining, the **MAST** Consortium Partners have agreed to present our definition of a machinist as follows:

MACHINIST - ***responsible for the planning, layout, set up, and operation of hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.***

Other related topics which are included in the **MAST** Machinist curriculum include:

- Computer Numerical Control (CNC)
- Electrical Discharge Machining (EDM)
- Precision Machining
- Grinding

MAST research indicates that a minimum of one year of occupational study and training will prepare students with the entry level skills necessary to enter the machinist trade. These findings led us to structure our pilot program to a one year schedule.

In this one year program, the students progress through a series of machine tool operations courses designed to constantly challenge the process skills on manual and Computer Numerical Controlled (CNC) machines. Along with comprehensive hands-on training, students also learn about the various types of materials and processes used by today's manufacturing industries. The Machining program at Texas State Technical College (TSTC) has been training entry level machinists for many years and works closely with advisory committee members to make sure that the skills being taught are the skills needed in industry. Students who graduate from this course of study receive certificates of completion from TSTC. The Machining faculty worked closely with the **MAST** staff and made every effort to adopt the recommended **MAST** materials not only for the pilot program, but also for their non-**MAST** students. The Machining program at TSTC is recognized throughout Texas by large and small manufacturing companies as a premier source for quality, entry-level machinists. Upon graduation, students are able to interpret complex drawings, select the correct materials and perform all necessary machining processes. The curriculum has been designed to prepare students to enter the machinist trade. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Machinist program falls under the umbrella of Manufacturing Engineering Technology (MET) at TSTC. The MET Department also offers Associate Degrees in two other exceptional areas of study. These are Computer-Aided Manufacturing and Plastic Processing.

This volume contains the justification, documentation and course syllabi for the courses which we recommend as minimum training for individuals desiring to become machinists.

PARTNER OCCUPATIONAL SPECIALITY ASSIGNMENTS

Although each of the six partner college development centers possessed detailed expertise in each of the MAST 15 occupational specialities, a division of work was still very necessary to ensure completion of the project due to the enormity associated with industrial assessment and complete curriculum revision for each of the areas of investigation.

Each Collegiate Partner was responsible for development of a specialization component of the overall model. Information for the future direction of this specialization area was obtained from NIST Manufacturing Centers and/or national consortia, professional societies, and industrial support groups addressing national manufacturing needs. Each Collegiate Partner tested its specialization model utilizing local campus resources and local industry. Information gained from the local experience was utilized to make model corrections. After testing and modification, components were consolidated into a national model. These events occurred during the first year of the Program. During the second year of the Program, the national model was piloted at each of the Collegiate Partner institutions. Experience gained from the individual pilot programs was consolidated into the final national model.

What follows is a profile of the MAST development center which had primary responsibility for the compilation and preparation of the materials for this occupational specialty area. This college also had the responsibility for conducting the pilot program which was used as one of the means of validation for this program.

MAST DEVELOPMENT CENTER
Texas State Technical College
Center for Contemporary Technology

Dr. Cecil L. Groves
Texas State Technical College System
Dr. Fred Williams, President
Texas State Technical College, Waco
Joe K. Penick, MAST Grant Director
Texas State Technical College, Waco

3801 Campus Drive
Waco, TX 76705
College phone: 817/799-3611 or 800-792-8784
fax:817-867-3380
Center phone: 817/867-4849, fax: 817/867-3380
e-mail: jpenick@tstc.edu

Manufacturing in Texas

Economic trends have led Texas officials to recognize the need to better prepare workers for a changing labor market. The downturn in the oil. natural gas, ranching and farming industries during the last decade diminished the supply of high-paying, low-skill jobs. Growth in Texas is occurring in the low paying, low skills service industry and in the high skills, high paying precision manufacturing industry. In Texas, projected increases by the year 2000 include 4,050 jobs for machine mechanics (24% growth rate); 4,700 jobs for machinists (18% growth rate); 3,850 numeric control operators (20% growth rate); and 107,150 general maintenance repair technicians (23% growth rate). The National Center for Manufacturing Sciences (NCMS) identified that of the top twenty manufacturing states, Texas experienced the largest increase in manufacturing employment. Manufacturing will add over 70,000 additional jobs in Texas by the year 2000 with increases in both durable and non-durable goods.

Texas State Technical College (TSTC)

Texas State Technical College System (TSTC) is authorized to serve the State of Texas through excellence in instruction, public service, research, and economic development. The system's efforts to improve the competitiveness of Texas business and industry include centers of excellence in technical program clusters on the system's campuses and support of educational research commercialization initiatives. Through close collaboration with business, industry, governmental agencies, and communities, including public and private secondary and postsecondary educational institutions, the system provides an articulated and responsive technical education system.

In developing and offering highly specialized technical programs and related courses, the TSTC system emphasizes the industrial and technological manpower needs of the state. Texas State Technical College is known for its advanced or emerging technical programs not commonly offered by community colleges.

New, high performance manufacturing firms in areas such as plastics, semiconductors and aerospace have driven dynamic change in TSTC's curriculum. Conventional metal fabrication to support oil and heavy manufacturing remains a cornerstone of the Waco campus and is a primary reason TSTC took the lead in developing new curricula for machining and manufacturing engineering technology in the MAST program.

Development Team

- **Project Director**: Joe K. Penick, Grant Director for Machine Tool Advanced Skills Technology Program (MAST); served as the primary administrator and academic coordinator for the MAST project.
- **Subject Matter Expert**: Wallace Pelton, Site Coordinator, was responsible for developing skill standards and course/program materials for the conventional machining, mold making and manufacturing engineering technology components of the MAST project.

THE MAST COMPETENCY PROFILE

Development of Competency Profiles at each of the MAST sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of their faculty, to employ a modified version of the generally-accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current and future industry requirements. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview statements designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of their region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, MAST staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that will have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. Copies of individual company competency profiles are provided in Appendix A of this volume. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industry and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document for which they could claim ownership. This, in effect, made them "real" partners in the work of MAST.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of, as shown in the following pages.

These same duties and tasks were then included in both the Texas and National Surveys for further validation (see Volume 1). As a result of the surveys, additional refinements were made to the Competency Profiles. These changes were then incorporated into the individual course syllabi which were used for the pilot program.

The MAST Competency Profile for this occupational specialty area has been included on the following pages.

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

CURRENT TRENDS/CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortium Partners
(V.199J40008)

*M*achine Tool *A*dvanced *S*kills *T*echnology Program

MAST

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MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

Duties		Tasks												
A	Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert metric/inch measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Calculate depth of cut on round surfaces			
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 Understand and use quality systems			
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Test metal samples for hardness	D-4 Describe welding operations									
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Perform measurements with hand held instruments	E-5 Perform measurements on surface plate	E-6 Perform inspections using stationary equipment							
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate deburring equipment				
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Operate electrical discharge machines	G-7 Program CNC machines using a CAM system						

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THE MAST TECHNICAL WORKPLACE COMPETENCY OUTLINE

The Competency Profiles derived from the industry survey process were returned to industry and faculty members at each MAST partner college for review. Reviewers were asked to identify specific sub-tasks within each block of Duties and Tasks in the Profile; MAST staff at each college broke the sub-tasks down further into the detailed steps required to actually perform the duties and tasks of the manufacturing process. It is these detailed skill standards that were then incorporated into development of the curriculum and piloted as a training program by each of the MAST colleges. All results for the specific occupational specialty area have been organized as an outline of the duties, tasks, and sub-tasks required to demonstrate technical competency in the workplace, as shown in the following pages.

As a result of the Texas and the National Surveys, additional refinements were made to the Competency Outlines. These changes were then incorporated into the individual course syllabi.

The MAST Technical Workplace Competency Outline for this occupational specialty area has been included on the following pages.

MACHINIST
TECHNICAL WORKPLACE COMPETENCIES

MACHINIST...*plan, layout, setup, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.*

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
    - a. Assume responsibility for the personal safety of oneself and others
    - b. Develop a personal attitude towards safety
    - c. Understand and comply with applicable regulations and industry standards
    - d. Comply with established company safety practices
2. Use Protective Equipment
    - a. Wear protective safety clothing as required
    - b. Maintain and use protective guards and equipment on machinery
    - c. Locate and properly use protective equipment
    - d. Use lifting aids when necessary
3. Follow Safe Operating Procedures for Hand and Machine Tools
    - a. Identify and understand safe machine operating procedures
    - b. Demonstrate safe machine operation
4. Maintain a Clean and Safe Work Environment
    - a. Keep work areas clean
    - b. Clean machine/hand tools when work is completed
    - c. Put tools away when work is finished
    - d. Keep aisles clear of equipment and materials
    - e. Perform preventive maintenance as required
    - f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS)

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
    - a. Add, subtract, multiply and divide whole numbers
    - b. Add, subtract, multiply, and divide fractions
    - c. Add, subtract, multiply, and divide decimals
2. Interconvert Fractions/Decimals
    - a. Convert fractions to decimal equivalents
    - b. Convert decimal values to nearest fractional equivalent
    - c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/Inch measurements
    - a. Convert inch dimensions to metric
    - b. Convert metric dimensions to inch
    - c. Use metric/inch conversion chart
4. Perform Basic Trigonometric Functions
    - a. Solve for unknown angles
    - b. Solve for unknown sides
    - c. Calculate bolt hole patterns
5. Calculate Speeds and Feeds for Machining
    - a. Calculate RPM for various metals and various tools

    - b. Calculate feed for various metals, tools, and depths of cut
6. Locate Machining Points from a Datum Point
    - a. Identify points using the Cartesian coordinate system
    - b. Identify points using the absolute dimensioning system
    - c. Identify points using the incremental dimensioning system
    - d. Identify points using the polar coordinate system
7. Perform Calculations for Sine Bar and Sine Plate
    - a. Calculate gage block build up for 5" sine bar
    - b. Calculate gage block build up for 10" sine plate
8. Calculate for Direct, Simple, and Angular Indexing
    - a. Calculate for direct indexing
    - b. Calculate for simple indexing (plain)
    - c. Calculate for angular indexing
    - d. Use Machinery's Handbook for calculations
9. Perform Calculations Necessary for Turning Tapers
    - a. Calculate tail stock offset
    - b. Determine unknowns (e.g., small and/or large diameters) for taper turning
10. Calculate Depth of Cut on Round Surfaces
    - a. Calculate depth of cut for flats to be machined on cylindrical pieces
    - b. Calculate depth of cut for keyways which are machined on cylindrical pieces

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
    - a. Explain basic blueprint terminology
    - b. Identify the types of dimensions
    - c. Identify general note symbols
    - d. Locate notes on a print
    - e. Interpret commonly used abbreviations and terminology
    - f. Determine tolerances associated with dimensions on a drawing
    - g. Determine the tolerance for a reference dimension
    - h. Determine the surface finish for a given part
    - i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
    - a. Identify types of lines within a drawing
    - b. Identify item number symbols
    - c. Identify general note symbols
    - d. List the essential components found in the title block
    - e. Locate bill of materials in a drawing
    - f. List the components found in the revision block
3. Identify Basic Types of Drawings
    - a. Identify orthographic views
    - b. Identify positions of views (top, front, side, and auxiliary)
    - c. Visualize one or more views from a given view
    - d. Identify isometric views
    - e. Identify exploded isometric drawings
    - f. Identify assembly drawings
4. List the Purpose of Each Type of Drawing

   - a. Identify the purpose of orthographic (3 views) drawings
   - b. Identify the purpose of isometric drawing
   - c. Identify the purpose of exploded isometric drawing
   - d. Identify the purpose of assembly drawings
5. Verify Drawing Elements
   - a. Determine the scale of the view or section
   - b. Check for revisions
   - c. Recognize out-of-date blueprints
6. Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology
   - a. Identify the purpose of GD&T
   - b. Identify symbols for controlling location (or true position) of part features
   - c. Identify symbols for controlling form (or alignment) of part features
   - d. Identify symbols for showing datums and basic dimensions on drawings
   - e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
7. Describe the Relationship of Engineering Drawings to Planning
   - a. Discuss production schedule
   - b. Discuss Material Resource Planning (MRP)
   - c. Discuss inventory control records
   - d. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
   - a. Discuss the purpose of standards
   - b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
   - a. Discuss components found on BOM
   - b. Determine materials needed to produce the part
   - c. Determine quantities necessary to produce the part
   - d. Submit completed stock request form as required
   - e. Submit completed tool request form as needed
10. Understand and Use Quality Systems
   - a. Understand and apply quality principles, including continuous improvement
   - b. Document paper trails for part revisions

D. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   - a. Discuss classification system for metals
   - b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
2. Describe the Heat Treating Process
   - a. Discuss the reasons for heat treating
   - b. Discuss the time/temperature chart
   - c. List the different quenching mediums
   - d. Estimate metal heat temperature by color
   - e. List reasons for stress relieving workpieces
   - f. Describe surface hardening processes
3. Test Metal Samples for Hardness

   - a. Perform spark test to test for metal hardness
   - b. Perform Rockwell hardness tests

4. Describe Welding Operations
   - a. Describe the SMAW process
   - b. Describe the Oxy-acetylene cutting and welding process
   - c. Describe the GTAW (Heliarc) process
   - d. Describe the GMAW (MIG) processes

E. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   - a. Discuss the use of metrology in manufacturing
   - b. Discuss the inch system of measurement
   - c. Discuss the metric system of measurement
   - d. Discuss semi-precision and precision measurement
   - e. Discuss the following: accuracy, precision, reliability, and discrimination
2. Select Proper Measurement Tools
   - a. Identify basic semi-precision measuring tools
   - b. Identify precision measuring tools
   - c. Justify the use of a particular measuring tool based on tool characteristics
   - d. Identify error possibilities in measurement tool selection
   - e. Demonstrate proper care of precision measuring tools
3. Apply Proper Measuring Techniques
   - a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration)
   - b. Explain calibration requirements of various precision instruments
   - c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   - d. Calibrate a micrometer type measuring tool
4. Perform Measurements With Hand Held Instruments
   - a. Measure with steel rules (metric and inch)
   - b. Measure with micrometers
   - c. Measure with comparison measuring instruments (e.g., calipers, telescope gages)
   - d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
   - e. Measure with fixed gages (go and not go gages)
5. Perform Measurements on Surface Plate
   - a. Describe care of surface plate
   - b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   - c. Check for part squareness
   - d. Check part dimensions for accuracy
   - e. Align workpieces using height gage and dial indicators
6. Perform Inspections Using Stationary Equipment
   - a. Set up and use an Optical Comparator
   - b. Set up and use a Coordinate Measuring Machine (CMM)

F. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations

   - a. Read and interpret blueprints
   - b. Perform basic semi-precision and precision layout as necessary
   - c. Plan machining operations
   - d. Understand machinability and chip formation
   - e. Calculate speeds, feeds, and depth of cut for various machine applications
   - f. Use carbides and other tool materials to increase productivity
   - g. Use the Machinery's Handbook as a reference for machine applications

2. Use Proper Hand Tools
   - a. Use arbor and shop presses
   - b. Select necessary work-holding devices and hand tools as needed
   - c. Select and use hand files
   - d. Identify and use hand reamers
   - e. Correctly identify and use hand taps as required
   - f. Follow tapping procedures to produce internal threads
   - g. Use thread-cutting dies to produce external threads
   - h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   - a. Use reciprocating and horizontal band cutoff machines
   - b. Operate abrasive and cold saws
   - c. Prepare and use the vertical band saw
   - d. Weld a bandsaw blade
4. Operate Drill Presses
   - a. Describe the different types of drill presses found in the machine shop
   - b. Describe and use standard drilling tools
   - c. Sharpen a drill bit using a bench or pedestal grinder
   - d. Setup the drill presses for drilling, countersinking, counterboring, reaming, and tapping operations
   - e. Drill holes using drill jigs
5. Operate Vertical Milling Machines
   - a. Demonstrate the use of all controls on the vertical milling machine
   - b. Align the vertical milling machine head
   - c. Select, align and use workholding devices
   - d. Select milling tool holders
   - e. Select milling cutters
   - f. Perform all standard vertical milling operations
   - g. Bore a hole using the offset boring head
   - h. Machine angles using sine bar and gage blocks
   - i. Setup and use special vertical mill fixtures
   - j. Setup and machine dovetails
   - k. Machine keyways
6. Operate Horizontal Milling Machines
   - a. Discuss the difference in plain and universal horizontal milling machines
   - b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
   - c. List several common work holding methods
   - d. Use plain milling cutters
   - e. Use side milling cutters
   - f. Use face milling cutters

   g. Setup and use special horizontal mill fixtures

7. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly
   d. Drill, ream and bore on the lathe
   e. Turn between centers
   f. Discuss alignment of lathe centers
   g. Make all calculations, lathe adjustments and settings to machine UNF and UNC series threads
   h. Discuss thread fit classifications
   i. Describe the common tapers used in the machine shop
   j. Discuss taper cutting and calculations for the lathe
   k. Setup and use the taper attachment found on most lathes
   l. Use follower rests and steady rests
   n. Use HSS cutting tools
   o. Use carbide cutting tools
8. Operate Grinding/Abrasive Machines
   a. Discuss the selection and identification of grinding wheels
   b. Inspect, mount, true, dress, and balance grinding wheels
   c. Discuss the selection of grinding fluids
   d. Operate horizontal spindle reciprocating table surface grinders
   e. Discuss common problems and solutions in surface grinding
9. Operate Deburring Equipment
   a. Debur parts using pneumatic deburring tools
   b. Debur parts using electric deburring tools

G. PERFORM ADVANCED MACHINING PROCESSES

1. Prepare and Plan For CNC Machining Operations
   a. Read and interpret blueprints
   b. Plan CNC machining operations
   c. Calculate speeds, feeds, and depth of cut for various CNC machine applications
   d. Determine proper cutting fluids/coolants for CNC machining
   e. Use the Machinery's Handbook as a reference for CNC machine applications
2. Select and Use CNC Tooling Systems
   a. Understand machinability and chip formation
   b. Select proper insert materials and geometry
   c. Assemble tooling components
   d. Select correct tooling systems
   e. Identify tooling cost factors
3. Program CNC Machines
   a. Identify CNC applications
   b. List various types of CNC machines
   c. Discuss CNC machine control systems
   d. Describe absolute and incremental coordinate systems
   e. Plan and write programs for CNC mills

    f. Plan and write programs for CNC lathes

4. Operate CNC Machining Centers (Mills)
    a. Install and align work holding devices
    b. Load/align materials into the machine
    c. Load tools into machine
    d. Establish tool length offset for each tool
    e. Establish/set machine reference
    f. Load programs into CNC mill
    g. Demonstrate working knowledge of all controls on the MCU
    h. Demonstrate proper operation of CNC machining center to include "dry run" and final production
    i. Edit CNC programs for optimum part production
    j. Operate machine in DNC mode if that capability exists
5. Operate CNC Turning Centers (Lathes)
    a. Install and true soft jaws as required
    b. Load tools into machine
    c. Establish machine reference
    d. Set initial tool offsets
    e. Monitor/adjust offsets for accurate part production
    f. Load programs into CNC lathe
    g. Demonstrate working knowledge of all controls on the MCU
    h. Demonstrate proper operation of CNC lathe to include "dry run" and final production
    i. Edit CNC programs for optimum part production
    j. Replenish stock in bar feeder as needed
6. Operate Electrical Discharge Machines
    a. Discuss the EDM process
    b. List advantages and disadvantages of the EDM process
    c. Identify electrode materials
    d. Machine EDM electrodes
    e. Setup and operate sinker EDM machines
    f. Calculate overburn
    g. Identify generator setting of machine
    h. Choose proper techniques for flushing
    i. Estimate number of roughers and finishers
    j. Demonstrate proper electrode mounting techniques
    k. Utilize 3R tooling
    l. Perform touch-off procedures
    m. Recognize optimum machine settings
    n. Perform continuity checks
    o. Determine R-MAX finish required
    p. Setup and operate wire cut EDM machines
7. Program CNC Machines using CAM System
    a. Create Job Plan for machining operations
    b. Construct part geometry
    c. Program tool path for roughing and finishing operations
    d. Verify tool path
    e. Generate CNC code

THE MAST PILOT PROGRAM CURRICULUM, COURSE DESCRIPTIONS AND CAPITAL EQUIPMENT LIST

After completing the Competency Profile and Technical Workplace Competency Outline for each occupational specialty area, each MAST partner reviewed their existing curricula against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MAST grant proposal:

- Pilot Program: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."

- Student Assessment: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry level and already-employed technicians."

(Note: All occupational specialty areas were not pilot tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following pages is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. This curriculum listing included course names and numbers from the college which conducted the pilot program. The curriculum also shows the number of hours assigned to each of the courses (lecture, lab and credit hours). Also included is a description of each of the courses. Also included in this section is a recommended list of tools, equipment and supplies which should be furnished by the school. This items on this list will be needed in addition to the tool list found in each of the course syllabi.

MANUFACTURING ENGINEERING TECHNOLOGY
MACHINING OPTION
CURRICULUM
1995-1996

		LEC	LAB	CR
FIRST QUARTER				
PSYC 1100*	College Success Skills	1	0	1
MET 100	Machine Tool Practices I	3	9	6
MET 1103	Precision Tools & Measurements	2	4	3
MET 1603	Industrial Specifications and Safety	2	4	3
MTH 115*	Occupational Mathematics	2	3	4
		10	20	17
SECOND QUARTER				
MET 200	Machine Tool Practices II	3	9	6
ENG 107*	Oral and Written Communications	3	0	3
WLT 105	Survey of Welding Processes and Appl.	3	3	4
PSY 112*	Human Relations	2	2	3
		11	14	16
THIRD QUARTER				
MET 300	Machine Tool Practices III	3	12	7
MET 301	Manufacturing Processes	3	3	4
MET 2303	Introduction to CNC	2	4	3
		8	19	14
FOURTH QUARTER				
MET 400	Machine Tool Practices IV	3	15	8
MET 2406	Advanced CNC	3	9	6
		6	24	14
	Program Totals	35	77	61

* Course Syllabi in Volume 2

MANUFACTURING ENGINEERING TECHNOLOGY
MACHINING OPTION
COURSE DESCRIPTIONS 1995-1996

MET 100	Machine Tool Practices I (3-9-6) Students will be assigned, specially designed projects that will be machined using the engine lathe, milling, machine, drill press, and various saws. The capability and safe use of the machine tools will be stressed.
MET 200	Machine Tool Practices II (3-9-6) A course designed to develop additional machine shop skills for those students who were successful in Machine Tool Practices I.
MET 300	Machine Tool Practices III (3-12-7) The students will be required to apply knowledge and skills gained in Machine Tool Practices I & II to make necessary calculations, select desired machine tools, plan machining operations and sequences to produce the required work from working drawing and sketches with a minimum of instructor prepared guidelines.
MET 301	Manufacturing Processes (3-3-4) Essential studies into the processes and materials for manufacturing, including metal casting, hot and cold forming of steel, powder metallurgy and plastics. Analysis of newer processes such as electrical discharge machining, chemical machining and ultra-sonic machining; with an emphasis on the economical manufacturing of products.
MET 400	Machine Tool Practices IV (3-15-8) This course is designed for the students that have successfully completed Machine Tool Practices I,II, and III. It will cover the machining skills they have mastered in their first three quarters at an advanced level. Additional skills such as production machining, production machine set up and fixturing along with working with assembly drawings will be covered.
MET 1103	Precision Tools and Measurements (2-4-3) Introduction to the function and reason for measurements. Relationship between different types of measuring tools that a machinist is required to use. Upon completion, the student will be able to properly handle, use, care and calibrate instruments.
MET 1603	Industrial Specifications and Safety (2-4-3) This course is designed to give the student an opportunity to study the fundamentals of specifications in the form of blueprints, work orders, and associated engineering directives. Safety as pertains to machining and shop operations will be covered.

MET 2303 **Introduction to CNC** (2-4-3) Give the student a basic knowledge of numerically controlled (NC) and computer numerically controlled (CNC) machine tools. Teaches differences between conventional and numerically controlled machines. Emphasis will be placed on safety of CNC machines. Principles of programming, tooling, setup and machine operations will be studied.

MET 2406 **Advanced CNC** (3-9-6) Continuation of MET 2303. Extends basic principles of numerical control to actual machine operations. Basic descriptions of computer numerical control and step-by-step procedures for planning and preparing a computer-assisted program are given. CNC lathe and CNC milling machine applications are utilized for machining of complete units or student laboratory projects.

MANUFACTURING ENGINEERING TECHNOLOGY
MACHINING OPTION
SUPPORT COURSES
1995-1996

PSYC 1100*	College Success Skills This course acquaints the students with the policies of the college, services available on and off the campus, and study skills along with other issues that will help them through their college studies. Students are required to take this course in their first quarter at TSTC.
ENG 107*	Oral & Written Communications The oral and written communications most needed by entry level technicians. Emphasis will be on oral communication situations between peers, between technician and supervisor or subordinate, and between technician and groups.
MTH 115*	Occupational Mathematics This course includes English and Metric systems of measurement, geometric principles, solutions of basic algebraic expressions and solutions of triangular trig problems. Problems from specific occupational areas will be stressed.
PSY 112*	Human Relations This course presents a study in the interaction of people in the business and industrial complex. Emphasis is placed on the necessity for a cooperative environment to satisfy individual needs as well as to increase production efficiency.
WLT 105	Survey of Welding Processes and Applications This course is a survey of shielded metal arc, gas tungsten arc, gas metal arc, flux cored arc, and submerged arc welding processes. Metals weldability and weld symbols are considered. Process safety, electrode selection, and process parameters are emphasized. Hard surfacing using shielded metal arc and oxyacetylene processes and techniques are studied.

* Course syllabi in Volume 2

RECOMMENDED CAPITAL EQUIPMENT, TOOLS, AND SUPPLIES FOR THE MACHINIST PROGRAM

The following tools, capital equipment and supplies will need to be furnished by the school. These items are needed in addition to the Student Tool List which is specified in the course syllabus. This list will need to be amended to include items which might be required for different laboratory projects selected for use by the instructors.

General Equipment/Supplies:

- First Aid Kit
- Machinist Hand and Measuring Tools
  - dial indicators
  - magnetic base
  - outside micrometers
  - inside micrometers
  - telescope gages
  - calipers
  - tap handles
  - die handles
  - wrenches
  - hacksaws
  - squares
  - other(s) as required
- Metal Lathe(s) w/attachments
- Lathe Tool Holders and Cutting Tools
- Vertical Mill(s) w/attachments
- Mill Tool Holders and End Mills
- Horizontal Mill w/attachments
- Drill Press(s) w/attachments
- Set of Drill Bits (as required)
- Set of Taps (as required)
- Set of Dies (as required)
- Set of Gage Blocks
- Sine Bar
- Surface Plate w/accessories
- Clamps
- Angle Plates
- Power Hand Drill
- Hydraulic/Arbor Press
- Power Cutoff Saw
- Vertical Band Saw w/blades
- Pedestal Grinders
- Work Benches
- Bench Vises
- Cutting Oil w/oil cans
- Grease Gun w/Grease
- Brooms & Dust Pans
- Bench Brushes
- Trash Cans
- Absorbent (for oil spills)
- Power Belt Sander
- Metal Storage Rack(s)
- Fire Extinguisher(s)
- Storage Cabinets (lockable)
- Tool Box Storage Racks (lockable)
- Coolant
- Fasteners (bolts, nuts, washers, rivets, etc.)

Specialized Equipment:

- Surface Grinder w/attachments
- CNC Vertical Machining Center w/attachments
- CNC Turning Center w/attachments
- Computer Programming Station(s) w/CAM software
- EDM (sinker type) Machine w/attachments
- Hardness Tester
- Coordinate Measurement Machine (CMM)
- Optical Comparator
- SMAW Arc Welder
- TIG Welder Setup
- MIG Welder Setup
- Oxy-acetylene Welding/Cutting Setup
- Coolant Recovery Equipment
- Forklift
- Ventilation Equipment
- Bead Blaster
- Sheet Metal Hand Tools
- Sheet Metal Shear
- Sheet Metal Finger Brake
- Iron Worker

THE MAST TECHNICAL WORKPLACE COMPETENCY/COURSE CROSSWALK

Upon development of appropriate curricula for the pilot programs, each MAST college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competency/Course Crosswalk in the following pages presents the match between industry-identified duties and tasks and the pilot curriculum for . Course titles are shown in columns, duties and tasks in rows. The Exit Level Proficiency Scale, an ascending scale with 5 the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1-5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

Included on the following pages is the Technical Workplace Competency/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi.

Page 1

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: MACHINIST

	College Success Skills	Machine Tool Practices I	Precision Tools & Measure.	Industrial Specs & Safety	Occupational Mathematics	Machine Tool Practices II	Oral/Written Communications	Survey of Weld. Proc./Applic.	Human Relations	Machine Tool Practices III	Manufacturing Processes	Introduction to CNC	Machine Tool Practices IV	Advanced CNC	EXIT PROFICIENCY LEVEL
A. PRACTICE SAFETY															
A-1 Follow Safety Manuals and All Safety Regulations/Requirements		X		X											4
A-2 Use Protective Equipment		X		X				X							4
A-3 Follow Safe Operating Procedures for Hand and Machine Tools		X		X		X		X		X	X		X	X	4
A-4 Maintain a Clean and Safe Work Environment		X		X											4
B. APPLY MATHEMATICAL CONCEPTS															
B-1 Perform Basic Arithmetic Functions					X										4
B-2 Interconvert Fractions/Decimals			X		X										4
B-3 Interconvert Metric/Inch measurements			X		X										3
B-4 Perform Basic Trigonometric Functions					X	X						X			3
B-5 Calculate Speeds and Feeds for Machining		X				X						X		X	3
B-6 Locate Machining Points From a Datum Point						X						X		X	3
B-7 Perform Calculations for Sine Bar and Sine Plate			X			X									2
B-8 Calculate for Direct, Simple, and Angular Indexing						X									2
B-9 Perform Calculations Necessary for Turning Tapers						X									2
B-10 Calculate Depth of Cut on Round Surfaces						X									2
C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS															
C-1 Review Blueprint Notes and Dimensions		X		X											3
C-2 Identify Basic Layout of Drawings		X		X											3
C-3 Identify Basic Types of Drawings		X		X											3
C-4 List the Purpose of Each Type of Drawing		X		X											3
C-5 Verify Drawing Elements				X											3
C-6 Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology				X											2
C-7 Describe the Relationship of Engineering Drawings to Planning				X							X				2
C-8 Use Standards to Verify Requirements				X							X				2
C-9 Analyze Bill of Materials (BOM)				X							X				2
C-10 Understand and Use Quality Systems													X		2
D. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES															
D-1 Identify Materials With Desired Properties										X	X				2
D-2 Describe Heat Treating Process										X					2

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: MACHINIST

	College Success Skills	Machine Tool Practices I	Precision Tools & Measure.	Industrial Specs & Safety	Occupational Mathematics	Machine Tool Practices II	Oral/Written Communications	Survey of Weld. Proc./Applic.	Human Relations	Machine Tool Practices III	Manufacturing Processes	Introduction to CNC	Machine Tool Practices IV	Advanced CNC	EXIT PROFICIENCY LEVEL
D-3 Test Metal Samples for Hardness										X					2
D-4 Describe Welding Operations								X							3
E. PERFORM MEASUREMENT/INSPECTION															
E-1 Identify Types of Measurement		X	X												4
E-2 Select Proper Measurement Tools		X	X												4
E-3 Apply Proper Measuring Techniques		X	X												4
E-4 Perform Measurements With Hand Held Instruments		X	X												4
E-5 Perform Measurements on Surface Plate		X	X												4
E-6 Perform Inspections Using Stationary Equipment			X												3
F. PERFORM CONVENTIONAL MACHINING OPERATIONS															
F-1 Prepare and Plan For Machining Operations		X													4
F-2 Use Proper Hand Tools		X													4
F-3 Operate Power Saws		X													
F-4 Operate Drill Presses		X													4
F-5 Operate Vertical Milling Machines		X				X									4
F-6 Operate Horizontal Milling Machine						X									4
F-7 Operate Metal Cutting Lathes		X				X									4
F-8 Operate Grinding/Abrasive Machines										X					3
F-9 Operate Deburring Equipment						X				X			X		4
G. PERFORM ADVANCED MACHINING PROCESSES															
G-1 Prepare and Plan for CNC Machining Operations												X			3
G-2 Select and Use CNC Tooling Systems														X	3
G-3 Program CNC Machines												X		X	3
G-4 Operate CNC Machining Centers (Mills)														X	3
G-5 Operate CNC Turning Centers (Lathes)														X	2
G-6 Operate Electrical Discharge Machines														X	1
G-7 Program CNC Machines using a CAM System														X	2

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THE MAST SCANS/COURSE CROSSWALK

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	Identifies, organizes, plans, and allocates resources
Interpersonal:	Works with others
Information:	Acquires and uses information
Systems:	Understands complex inter-relationships
Technology:	Works with a variety of technologies

FOUNDATION SKILLS:

Basic Skills:	Reads, writes, performs arithmetic and mathematical operations, listens and speaks
Thinking Skills:	Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
Personal Qualities:	Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

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Recognizing the value of SCANS proficiencies to job performance, as well as the growing mandate in many states to include SCANS activities in course curricula, MAST asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. MAST also incorporated evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed MAST staff to modify course content where needed to strengthen achievement of SCANS competencies.

The following pages present the SCANS/Course Crosswalk for the pilot curriculum in Courses are listed along the top and SCANS competencies and foundations are shown along the left side of the matrix. An exit level proficiency matrix for SCANS competencies and foundation skills is provided as well.

As "soft" skills, the SCANS competencies are inherently difficult to quantify. MAST realizes that some faculty will emphasize the SCANS more or less than others. The SCANS/Course Crosswalk matrix has been included with this course documentation to show the importance of these "soft skills" and the importance of their being addressed in the classroom (particularly in technical classes). In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

Included on the following pages is the SCANS/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the "soft skills" (SCANS) which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi. Also included is a matrix which defines the exit level of proficiency scale (1-5).

SCANS/Course

CROSSWALK

MACHINIST: CERTIFICATE

COMPETENCY	College Success Skills	Machine Tool Practices I	Precision Tools & Measure.	Industrial Specs & Safety	Occupational Math	Machine Tool Practices II	Oral/Written Communications	Survey of Weld. Proc./Applic.	Human Relations	Machine Tool Practices III	Manufacturing Processes	Introduction to CNC	Machine Tool Practices IV	Advanced CNC	EXIT PROFICIENCY LEVEL
(RS) RESOURCES:															
A. Allocates time	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Allocates money		X	X	X		X		X		X	X	X			2
C. Allocates material and facility resources	X	X	X	X		X		X		X	X	X	X	X	4
D. Allocates human resources	X	X		X		X	X		X	X	X	X	X	X	1
(IN) INTERPERSONAL SKILLS:															
A. Participates as a member of a team	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Teaches others	X	X	X	X		X	X	X	X	X	X	X	X	X	1
C. Serves clients/customers	X	X		X		X		X	X	X	X	X	X	X	2
D. Exercises leadership	X	X	X	X		X		X	X	X	X	X	X	X	1
E. Negotiates	X			X				X	X		X				1
F. Works with cultural diversity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(IF) INFORMATION SKILLS:															
A. Acquires and evaluates information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Organizes and maintains information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Interprets and communicates information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
D. Uses computers to process information			X		X		X					X		X	2
(SY) SYSTEMS:															
A. Understands systems	X	X	X		X	X	X	X	X	X	X	X	X	X	4
B. Monitors and corrects performance		X	X			X	X	X		X	X	X	X	X	2
C. Improves and designs systems		X	X			X		X		X	X	X	X	X	1
(TE) TECHNOLOGY:															
A. Selects technology		X	X	X	X	X	X	X		X	X	X	X	X	4
B. Applies technology to task		X	X	X	X	X	X	X		X	X	X	X	X	4
C. Maintains and troubleshoots technology		X	X	X		X		X		X	X	X	X	X	3

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SCANS/Course

CROSSWALK

MACHINIST: CERTIFICATE

FOUNDATION SKILLS	College Success Skills	Machine Tool Practices I	Precision Tools & Measure.	Industrial Specs & Safety	Occupational Math	Machine Tool Practices II	Oral/Written Communications	Survey of Weld. Proc./Applic.	Human Relations	Machine Tool Practices III	Manufacturing Processes	Introduction to CNC	Machine Tool Practices IV	Advanced CNC	EXIT PROFICIENCY LEVEL
(BS) BASIC SKILLS:															
A. Reading	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Writing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
C. Arithmetic and mathematics	X	X	X	X	X	X		X		X	X	X	X	X	4
D. Listening	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Speaking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(TS) THINKING SKILLS:															
A. Creative thinking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Decision making	X	X	X	X	X	X	X	X	X	X	X	X	X	X	2
C. Problem solving	X	X	X	X	X	X	X	X	X	X	X	X	X	X	2
D. Seeing things in the mind's eye	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Knowing how to learn	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
F. Reasoning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(PQ) PERSONAL QUALITIES:															
A. Responsibility	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Self-esteem	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Social	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
D. Self-management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Integrity/honesty	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4

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SCANS
COMPETENCIES AND FOUNDATION SKILLS
EXIT LEVEL PROFICIENCY MATRIX

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in it's "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources: Identifies, organizes, plans, and allocates resources
Interpersonal: Works with others
Information: Acquires and uses information
Systems: Understands complex inter-relationships
Technology: Works with a variety of technologies

FOUNDATION SKILLS:

Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

The following matrix identifies the five exit levels of proficiency that are needed for solid job performance.

EXIT LEVEL OF PROFICIENCY					
SCANS Competencies and Foundation Skills	**1**	**2**	**3**	**4**	**5**
	rarely	routinely with supervision	routinely with limited supervision	routinely without supervision	initiates/ improves/ modifies and supervises others

THE MAST COURSE SYLLABI
"PILOT PROGRAM"

MAST has produced a very unique set of course outlines, driven and validated by industry and encompassing the broad range of technologies covered by the MAST grant. The course outlines also include proposed SCANS activities that will be useful to an instructor in preparing students to enter the workforce of the future.

Included in the following pages are final course outlines developed and refined in the process of piloting the MAST training programs. The outlines include a brief course description; required course materials (e.g., textbook, lab manual, and tools, if available); proposed method of instruction; proposed lecture and lab outlines; and detailed course objectives for both Technical Workplace Competencies and SCANS Competencies.

These outlines were completed and revised during the second year of MAST, following completion of the pilot phase. The outlines are intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

Included on the following pages are the Course Syllabi for each of the courses which were taught during the pilot program.

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

MACHINE TOOL PRACTICES I

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL PRACTICES I

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

Students will be assigned specifically designed projects that will be machined using the engine lathe, milling machine, drill press, and various saws. The capability and safe use of machine tools will be stressed.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual: Machine Tool Practices I, Raborn, TSTC Pub., 4th Ed.

Student Tool List **	**Qty. Req'd.**
Tool Box	1
Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch
Ball Peen Hammer	1
10 inch Adjustable Wrench	1
Center Punch	1
Magic marker, Jumbo, black.	1
Aluminum Oxide Cloth, 9" X 11", 240 Grit	2 sheets
Aluminum Oxide Cloth, 9" X 11", 320 Grit	2 sheets
Tool Steel, 3/8", H.S.S.	2
Flat Mill Bastard File, 10 inch.	1
File Handle	1
Allen Wrench Set, Long English and Metric	1 each
Center Drill #3	1
Scribe	1
Center Gage	1
Screw Driver, 8 inch	1
File Card Brush	1
0-6 inch Dial Calipers	1
Shop Apron (blue denim)	1
Shop Towels (1 roll)	1

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments and oral presentations
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to the Course	---	1
Safety	5-12	1
Tool Grinding	43-45 (lab book)	1
The Machine Shop	1-4	1
The Inch Rule	113-118	1
The Square	163-166	1
The Inch Micrometer	140-145	1
Drawings	28-36	2
Layout Tools	249-262	2
QUIZ I (over above lectures)	---	1
Semi-precision Layout	262-266	1
Hand Tools	46-55	1
Hacksaws	55-58	1
Files	58-63	1
Verniers	122-125	1
Vernier Micrometers	151-156	1
The Drill Press	365-374	1
Drilling Tools	375-384	2
QUIZ 2 (over above lectures)	---	1
Drilling Operations	389-402	2
Taps	68-74	1
Tapping Procedures	74-79	1
Gage Blocks	178-187	1
Angular Measuring	187-195	1
Precision Layout	267-280	2

QUIZ 3 (over above lectures)	---	1
Oral Presentations*	---	5
	Total Lecture Hours	**36**

(10-15 minute student presentations on assigned machine-related topics. These topics could include future trends or special concerns of the machine tool industry.)

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
Shop orientation	2
Use of the cut-off saw	2
Grinding a lathe tool	3
Grinding a mill tool	3
Using the band saw	3
Using the radial drill	3
Using the sensitive drill	3
Bench work	27
Lathe work	27
Mill work	27
Leaving the shop in order	3
Inspecting the finished work	5
Total Lab Hours	**108**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **PRACTICE SAFETY**
    1. Follow Safety Manuals and All Safety Regulations/Requirements
        a. Assume responsibility for the personal safety of oneself and others
        b. Develop a personal attitude towards safety
        c. Comply with established safety practices
    2. Use Protective Equipment
        a. Wear protective safety clothing as required
        b. Maintain and use protective guards and equipment on machinery
        c. Locate and properly use protective equipment
        d. Use lifting aids when necessary
    3. Follow Safe Operating Procedures for Hand and Machine Tools
        a. Understand and apply safe machine operating procedures
        b. Demonstrate safe machine operation
    4. Maintain a Clean and Safe Work Environment
        a. Keep work areas clean
        b. Clean machine/hand tools when work is completed
        c. Put tools away when work is finished
        d. Keep aisles clear of equipment and materials

B. **APPLY MATHEMATICAL CONCEPTS**
    1. Calculate Speeds and Feeds for Machining

   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify general note symbols
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
4. List the Purpose of Each Type of Drawing
   a. Identify the purpose of orthographic (3 views) drawings

D. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Discuss the use of metrology in manufacturing
   b. Discuss the inch system of measurement
   c. Discuss the metric system of measurement
   d. Discuss semi-precision and precision measurement
   e. Discuss the following: accuracy, precision, reliability, and discrimination
2. Select Proper Measurement Tools
   a. Identify basic semi-precision measuring tools
   b. Identify precision measuring tools
   c. Justify the use of a particular measuring tool based on tool characteristics
   d. Identify error possibilities in measurement tool selection
   e. Demonstrate proper care of precision measuring tools
3. Apply Proper Measuring Techniques
   a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration)
   b. Explain calibration requirements of various precision instruments
   c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   d. Calibrate a micrometer type measuring tool
4. Perform Measurements With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers
   c. Measure with comparison measuring instruments (e.g., calipers, telescope gages)
   d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
   e. Measure with fixed gages (go and not go gages)

5. Perform Measurements on Surface Plate
   - a. Describe care of surface plate
   - b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   - c. Check for part squareness
   - d. Check part dimensions for accuracy
   - e. Align workpieces using height gage and dial indicators

E. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   - a. Read and interpret blueprints
   - b. Perform basic semi-precision and precision layout as necessary
   - c. Plan machining operations
   - d. Calculate speeds, feeds, and depth of cut for various machine applications
   - e. Use carbides and other tool materials to increase productivity
2. Use Proper Hand Tools
   - a. Use arbor and shop presses
   - b. Select necessary work-holding devices and hand tools as needed
   - c. Select and use hand files
   - d. Identify and use hand reamers
   - e. Correctly identify and use hand taps as required
   - f. Follow tapping procedures to produce internal threads
   - g. Use thread-cutting dies to produce external threads
   - h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   - a. Use reciprocating and horizontal band cutoff machines
   - b. Prepare and use the vertical band saw
4. Operate Drill Presses
   - a. Describe the different types of drill presses found in the machine shop
   - b. Describe and use standard drilling tools
   - c. Setup the drill presses for drilling, countersinking, counterboring, and reaming operations
5. Operate Vertical Milling Machines
   - a. Demonstrate the use of all controls on the vertical milling machine
   - b. Align the vertical milling machine head
   - c. Select, align and use workholding devices
   - d. Select milling tool holders
   - e. Select milling cutters
   - f. Perform all standard vertical milling operations
6. Operate Metal Cutting Lathes
   - a. Demonstrate the use of all controls on the engine lathe
   - b. Discuss standard tools and toolholders for the lathe
   - c. Face and center drill parts correctly
   - d. Drill, ream and bore on the lathe
   - e. Make all calculations, lathe adjustments and settings to machine sixty degree external threads
   - f. Use HSS cutting tools
   - g. Use carbide cutting tools

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. follows a schedule to complete assigned tasks on time
    2. follows a schedule to maximize laboratory resources
    3. complete a stock request form for required material
- *B.* ***Interpersonal:*** *Works with others*
    1. complete assigned responsibilities within the shop floor serving as a member of the team
    2. provide individual assistance/direction to peers as requested
- *C.* ***Information:*** *Acquires and uses information*
    1. read and interpret blueprints
    2. organize and apply theories of machine tool operation
    3. perform basic semi-precision and precision layout as necessary
- *D.* ***Systems:*** *Understands complex inter-relationships*
    1. demonstrate knowledge of the following systems:
        - a. organization of personnel and facilities on the shop floor
        - b. systematic approach to the metal removal process
        - c. dimensioning and measurement systems
    2. monitors and corrects performance during
        - a. the machining process
        - b. adjustments of individual laboratory work schedule
        - c. constantly evaluating the quality of work to achieve acceptable standards
- *E.* ***Technology:*** *Works with a variety of technologies*
    1. chooses procedure, tools and equipment required to produce a part
    2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

II. FOUNDATION SKILLS

- *A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. read/studies textbook
        - b. studies student laboratory manual

c. interprets blueprints and technical drawings
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. interconverts fractions to decimal expressions
   c. keeps a running computation of individual grade
   d. calculate tap drill size
4. ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe and assimilate laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
   e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
5. ***Speaking:** Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
   e. plan and deliver a 10-15 minute oral presentation on an assigned machine-related topic

B. ***Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
   1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
      a. decides upon a job process plan to produce a part to specifications, given constraints of available time, equipment and other resources
      b. prioritizes activities for effective use of time
   2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
      a. makes daily accommodations to stay on schedule
      b. seeks additional instruction/clarification for assignment completion
      c. troubleshoots machining processes and equipment
      d. recognize problems in machining and selects appropriate corrective or preventive action

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. visualize objects in three dimensions from engineering drawings
   b. visualize process during instructor lecture
   c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. understand that practice will improve skill
   b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. applies knowledge of principles of machining to troubleshoot process problems
   b. applies knowledge of machining process to develop a logical, sequential process plan
   c. applies knowledge of workpiece machinability, cutter characteristics and machine tool characteristics to adjust speeds and feeds

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. displays promptness and preparation for the day's work
   b. plans work to use time efficiently
   c. accepts responsibility for mistakes, and takes corrective and preventive actions
   d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. takes pride in work through positive reinforcement
   b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual gradebook)
   c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. accept the responsibility for own actions
    b. exhibit personal honesty at all times
    c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
    d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers

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*M*achine Tool *A*dvanced *S*kills
*T*echnology Program
MAST

COURSE SYLLABUS

PRECISION TOOLS & MEASUREMENTS

MAST PROGRAM
COURSE SYLLABUS
PRECISION TOOLS & MEASUREMENTS

Lecture hours/week: 2	**Lab hours/week: 4**	**Credit hours: 3**

COURSE DESCRIPTION:

Introduction to the function and reason for measurements. Relationship between different types of measuring tools that a machinist is required to use. Upon completion, the student will be able to properly handle, use, care for, and calibrate measuring instruments.

This course is designed to familiarize the student with the use, handling and maintenance of a variety of precision tools and instruments which will be encountered in industry. Care and calibration of instruments and metric conversions will be covered.

Students will use measuring tools such as: rulers, surface gages, verniers, micrometers, dial indicators, dial test indicators, gage blocks and accessories, electronic indicators, optical comparators, precision height gages, ring and plug gages, thread gages, snap gages, v-blocks, 1-2-3 blocks, angle plates and surface plates to check test specimens for: locations of holes, radii etc., lengths, diameters, surface finish, parallelism, squareness, and concentricity, rectangular coordinates, angles, thread fits, maximum and minimum material condition to tolerances as close as +/-.000010". Students will also learn to make comparison measurements and inspections using the optical comparator and the coordinate measuring machine (CMM).

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook:	Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual:	None

Student Tools List ****/Qty. Req'd:** Same as for Machine Tool Practices I

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will consist of "hands-on" activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform satisfactorily on written, oral, or practical examinations
4. perform satisfactorily on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Precision Tools and Measurement	89	1
Measuring with Ruled Instruments (English and metric)	108	2
Measuring with Vernier Measuring Tools	122	2
Measuring with Micrometer Measuring Tools	133	2
Using Gage Blocks and Accessories	178	3
Measuring Angles	187	2
Making Comparison Measurements	157	2
Measuring with Fixed and Adjustable Gages	94	2
Using High Amplification Electrical Comparators	105	2
Using Optical Comparators	176	2
Using Coordinate Measuring Machines	103	3
Final Examination		1
	Total Lecture Hours	**24**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Using the inch & metric measuring systems	3
Make measurements with inch & metric ruled instruments	1
Measure with inch & metric vernier tools	2
Measure with inch & metric dial calipers	1
Read and use inch & metric micrometer tools	2
Calculate gage block requirements	2
Clean and assemble required gage blocks and accessories	1
Calibrate measuring tools with gage blocks	2
Use gage blocks for direct measurement	1
Identify types of angles	1

Measure angles with protractor head and rule	1
Measure angles with the vernier protractor	2
Measure angles with sine bar, sine plate, gage blocks, etc.	2
Make semi-precision comparison measurements	1
Make precision comparison measurements within +/- .001"	2
Make precision comparison measurements within +/- .0001"	2
Measure with fixed gages	1
Measure with adjustable gages	2
Use dial indicator comparators	1
Use precision height gages	1
Use a Reed-type comparator	1
Measurement by motion using the optical comparator	3
Measurement by comparison using the optical comparator	2
Angular measurement using the optical comparator	3
Measure with the super micrometer	1
Measure with the multi-scale electronic comparator	2
Measure/Inspect using the Coordinate Measuring Machine (CMM)	5
Total Lab Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **APPLY MATHEMATICAL CONCEPTS**
  1. Interconvert Fractions/Decimals
    a. Convert fractions to decimal equivalents
    b. Convert decimal values to nearest fractional equivalent
    c. Use Decimal Equivalent Chart for conversions
  2. Interconvert Metric/Inch Measurements
    a. Convert inch dimensions to metric
    b. Convert metric dimensions to Inch
    c. Use metric/inch conversion chart
  3. Perform Calculations for Sine Bar and Sine Plate
    a. Calculate gage block build up for 5" sine bar

B. **PERFORM MEASUREMENT/INSPECTION**
  1. Identify Types of Measurement
    a. Discuss the use of metrology in manufacturing
    b. Discuss the English system of measurement
    c. Discuss the Metric system of measurement
    d. Discuss semi-precision and precision measurement
    e. Discuss the following: accuracy, precision, reliability, and discrimination
  2. Select Proper Measurement Tools
    a. Identify basic semi-precision measuring tools
    b. Identify precision measuring tools
    c. Justify the use of a particular measuring tool based on tool characteristics
    d. Identify error possibilities in measurement tool selection
    e. Demonstrate proper care of precision measuring tools

3. Apply Proper Measuring Techniques
    a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration)
    b. Explain calibration requirements of various precision instruments
    c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
    d. Calibrate a micrometer type measuring tool
4. Perform Measurements With Hand Held Instruments
    a. Measure with steel rules (metric and inch)
    b. Measure with micrometers
    c. Measure with comparison measuring instruments (e.g., calipers, telescope gages)
    d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
    e. Measure with fixed gages (go and not go gages)
5. Perform Measurements on Surface Plate
    a. Describe care of surface plate
    b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
    c. Check for part squareness
    d. Check part dimensions for accuracy
    e. Align workpieces using height gage and dial indicators
6. Perform Inspections Using Stationary Equipment
    a. Set up and use an Optical Comparator
    b. Set up and use a Coordinate Measuring Machine (CMM)

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- ***A. Resources:** Identifies, organizes, plans, and allocates resources*
    1. follows a schedule to complete assigned tasks on time
    2. follows a schedule to maximize metrology lab resources
- ***B. Interpersonal:** Works with others*
    1. complete assigned activities within the metrology lab serving as a member of the team
    2. provide individual assistance/direction to peers as requested
    3. works well with classmates, instructors and supervisors

- C. ***Information:** Acquires and uses information*
  - 1. read and interpret tolerances and dimensions from engineering drawings
  - 2. organize and apply theories of precision measurement
  - 3. perform semi-precision and precision measurements as required
- D. ***Systems:** Understands complex inter-relationships*
  - 1. demonstrate knowledge of the following systems:
    - a. organization of personnel and facilities in the metrology lab
    - b. systematic approach to the measurement in the machine shop
    - c. dimensioning and measurement systems
  - 2. monitors and corrects performance during
    - a. the measurement and inspection processes
    - b. adjustments of individual laboratory work schedule
- E. ***Technology:** Works with a variety of technologies*
  - 1. chooses procedure, tools and instruments required to accurately measure a machined part
  - 2. applies appropriate procedures and uses appropriate tools and instruments to consistently measure a part to the required tolerances

II. FOUNDATION SKILLS

- A. ***Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - *1.* ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. read/studies textbook
    - b. studies student laboratory worksheets
    - c. follow a daily laboratory schedule to maintain appropriate time-line and completion of course requirements
  - *2.* ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. maintain a lecture notebook
    - b. submit written responses to chapter question assignments
  - *3.* ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. interconverts inch to metric
    - b. interconverts fractions to decimal expressions
    - c. keeps a running computation of individual grade
    - d. calculate gage block buildup
  - *4.* ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. assimilate classroom instruction
    - b. interpret and assimilate video instruction
    - c. observe and assimilate laboratory demonstrations
    - d. seek and receive individualized instruction in the laboratory
    - e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics

5. ***Speaking:** Organizes ideas and communicates orally*
    a. participates in classroom discussions
    b. organize ideas and communicate specific questions to the instructor
    c. verbally affirms understanding of a concept, procedure, or required skill
    d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the metrology lab

B. ***Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
  1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. selects appropriate instruments from those available to perform the measurement task at hand
    b. applies judgement in the use of precision instruments to determine whether dimensions are within tolerance
    c. makes initial determination for rework or other disposition of parts found to be out of tolerance
  2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
    a. makes daily accommodations to stay on schedule
    b. seeks additional instruction/clarification for assignment completion
    c. plans and executes set-ups for surface plate measurements of complicated parts
  3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. visualize process during instructor lecture
    b. visualizes three-dimensional geometry from technical drawings and selects appropriate instruments to measure dimensions
  4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. understand that practice will improve skill
    b. asks questions or seeks help when uncertain about new skills or knowledge
  5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. considers relationships of part features, such as perpendicularity, cylindricity, angles and radii, and selects appropriate instruments and methods to measure those relationships for conformance to requirements

C. ***Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
  1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    a. displays promptness and preparation for the day's work
    b. plans work to use time efficiently
    c. accepts responsibility for mistakes, and takes corrective and preventive actions

   - d. takes initiative when needed to gain resources or assistance to complete assignments

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   - a. takes pride in work through positive reinforcement
   - b. sees self as a valued member of the group through continued contributions toward common goals

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. assist classmates in improving technical skills
   - b. share laboratory resources (measurement instruments, accessories and instructor's individual attention)

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. perform in-process checks to insure accuracy in measurement
   - b. maintain a record of academic achievement (individual grade book)
   - c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them

5. *Integrity/Honesty: Chooses ethical courses of action*
   - a. accept the responsibility for own actions
   - b. exhibit personal honesty at all times
   - c. accept the challenge of doing your own work in the metrology lab, during examinations and on lab assignments
   - d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Mathematics for Machine Technology; Robert Smith, Delmar Publishers

_M_achine Tool _A_dvanced _S_kills
_T_echnology Program

MAST

COURSE SYLLABUS

INDUSTRIAL SPECIFICATIONS AND SAFETY

MAST PROGRAM
COURSE SYLLABUS
INDUSTRIAL SPECIFICATIONS AND SAFETY

Lecture hours/week: 2 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

This course is designed to give the student an opportunity to study the fundamentals of specifications in the form of blueprints, work orders, and associated engineering directives. Safety as pertains to machining and shop operations will be covered.

Students will identify potential hazards in the machine shop area(s) and will be required to develop and implement preventive or corrective action(s). The student will be required to interpret various blueprint dimensions, machining symbols, tolerance zones, Geometric Dimensioning & Tolerancing (GD&T) symbols, machining details, sectional views, and perform basic shop sketching.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook/Lab Manual: Blueprint Reading for Manufacturing, Edward Hoffman and Paul Wallach, Delmar Publishers, Latest Edition.

Student Tool List **/Quantity Required: None

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video, and instructor demonstrations.

Laboratory: Laboratory will consist of hands-on activities. Students will complete exercises in their laboratory workbooks.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments

3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to the course		1
Safety in the machine shop	Technical Modules MAC-A1 "Follow Safety Manuals and All Safety Regulations/Requirements"	1
	Technical Modules MAC-A2 "Use Protective Equipment"	1
	Technical Modules MAC-A3 "Follow Safe Operating Procedures for Hand and Machine Tools"	1
	Technical Modules MAC-A4 "Maintain a Clean and Safe Work Environment"	1
Features of the blueprint	9	2
Interpreting print dimensions	117	2
Identifying the characteristics of detail and assembly prints	153	2
Identifying the types and uses of sectional views	167	2
Interpreting machine details on blueprints	183	3
Interpreting geometric dimensioning and tolerancing control symbols (GD&T)	233	3
Interpreting metric blueprint dimensions	295	2
Basic shop sketching techniques	39	1
Reading and interpreting industrial blueprints, engineering directives and work orders		2
	Total Lecture Hours	**24**

LAB OUTLINE:

Lecture Topics	Exercise Reference	Contact Hrs.
Identify features on a blueprint	E2-1	2
Interpret print dimensions	E8-1, 2, 3	6
Identify characteristics of detail & assembly prints	E9-1, 2	4
Identify the types and uses of sectional views	E10-1, 2	4

Interpret machine details on blueprints	E11-1, 8	4
Interpret Geometric Dimensioning and Tolerancing control symbols	E12-1	4
Interpret metric blueprint dimensions	E15-1, 2	4
Perform basic shop sketching	E4-1, 2, 3, 4	6
Read and interpret industrial blueprints, engineering directives and work orders		12
	Total Lab Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   a. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when necessary
3. Follow Safe Operating Procedures for Hand and Machine Tools
   a. Identify and understand safe machine operating procedures
   b. Demonstrate safe machine operation
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Clean machine/hand tools when work is completed
   c. Put tools away when work is finished
   d. Keep aisles clear of equipment and materials
   e. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS)

B. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols

    c. Identify general note symbols
    d. List the essential components found in the title block
    e. Locate bill of materials in a drawing
    f. List the components found in the revision block
3. Identify Basic Types of Drawings
    a. Identify orthographic views
    b. Identify positions of views (top, front, side, and auxiliary)
    c. Visualize one or more views from a given view
    d. Identify isometric views
    e. Identify exploded isometric drawings
    f. Identify assembly drawings
4. List the Purpose of Each Type of Drawing
    a. Identify the purpose of orthographic (3 views) drawings
    b. Identify the purpose of isometric drawing
    c. Identify the purpose of exploded isometric drawing
    d. Identify the purpose of assembly drawings
5. Verify Drawing Elements
    a. Determine the scale of the view or section
    b. Check for revisions
    c. Recognize out-of-date blueprints
6. Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology
    a. Identify the purpose of GD&T
    b. Identify symbols for controlling location (or true position) of part features
    c. Identify symbols for controlling form (or alignment) of part features
    d. Identify symbols for showing datums and basic dimensions on drawings
    e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
7. Describe the Relationship of Engineering Drawings to Planning
    a. Discuss production schedule
    b. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
    a. Discuss the purpose of standards
    b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
    a. Discuss components found on BOM
    b. Determine materials needed to produce the part
    c. Determine quantities necessary to produce the part

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  - 1. follows a schedule to complete assigned tasks on time
  - 2. recognize hazards and selects and correctly uses protective equipment and other safeguards
- B. ***Interpersonal:*** *Works with others*
  - 1. complete assigned responsibilities within the classroom serving as a member of the team
  - 2. provide individual assistance/direction to peers as requested
  - 3. maintains an awareness and concern for the safety of others as well as self
- C. ***Information:*** *Acquires and uses information*
  - 1. read and interpret blueprints
  - 2. read and understand safety rules and regulations, Material Safety Data Sheets, warning signs, labels, and symbols related to job safety and health
  - 3. uses standard reference manuals and tables to locate specifications and other reference information
- D. ***Systems:*** *Understands complex inter-relationships*
  - 1. demonstrate knowledge of the following systems:
    - a. recognize major sources of standards and reference materials
    - b. recognize structure of federal, state and local, and company-level rules and regulations for safety, health, and the environment
    - c. recognize and understand the complex documentation required for communication within the manufacturing process

II. FOUNDATION SKILLS

- A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. read/studies textbook
    - b. interprets blueprints and technical drawings
    - c. read and understand reference manuals and tables, safety rules and regulations, written work instructions and forms
    - d. follow a daily laboratory schedule to maintain appropriate time-line and completion of course requirements
  - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. accurately fill out a sample accident report
    - b. maintain a lecture notebook
    - c. submit written responses to chapter question assignments
  - *3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

        a. locates and applies formulas from reference manuals
        b. makes calculations based on values from tables and manuals
    4. ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
        a. assimilate classroom instruction
        b. interpret and assimilate video instruction
        c. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
    5. ***Speaking:** Organizes ideas and communicates orally*
        a. participates in classroom discussions
        b. organize ideas and communicate specific questions to the instructor
        c. verbally affirms understanding of a concept, procedure, or required skill

B. ***Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
    1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. recognizes and evaluates hazards and makes appropriate decisions on the use of protective equipment and safeguards
        b. interprets specifications and makes judgement on how best to meet the specification with available resources
    2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
        a. makes daily accommodations to stay on schedule
        b. seeks additional instruction/clarification for assignment completion
        c. recognizes hazards and develops ways to eliminate or protect against the hazards
        d. uses reference manuals to locate information needed for problem solving
    3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
        a. visualize objects in three dimensions from engineering drawings
        b. visualize process during instructor lecture
        c. recognizes hazards
    4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. understand that practice will improve skill
        b. asks questions or seeks help when uncertain about new skills or knowledge
    5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. identifies requirements and specifications, and reasons a way to conform or measure for conformance
        b. recognizes combinations of factors that produce personal hazards or threats to the process

C. ***Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    a. displays promptness and preparation for the day's work
    b. plans work to use time efficiently
    c. accepts responsibility for mistakes, and takes corrective and preventive actions
    d. takes initiative when needed to gain resources or assistance to complete assignments
    e. accepts responsibility and demonstrates concern for safety of self and others
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    a. takes pride in work through positive reinforcement
    b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. assist classmates in improving technical skills
    b. share laboratory resources
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. maintain a record of academic achievement (individual grade book)
    b. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. ***Integrity/Honesty:** Chooses ethical courses of action*
    a. accept the responsibility for own actions
    b. exhibit personal honesty at all times
    c. accept the challenge of doing your own work in the classroom during examination, and on classroom exercises
    d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program
MAST

COURSE SYLLABUS

MACHINE TOOL PRACTICES II
Prerequisite: MACHINE TOOL PRACTICES I

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL PRACTICES II

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

This course is designed to develop additional machining skills for those students who have the basic skills that were developed in Machine Tool Practices I.

The student will work from more complex engineering drawings and use the engine lathe and milling machines to produce parts that will assemble into a functioning machine. Precision work and the control of surface finishes will be stressed. The engine lathe will be used to turn, taper, thread, bore, ream and knurl several parts. The milling machine will be used to cut keyways, mill precise angles and bore holes. The safe operation and maintenance of the machine shop will also be an important objective.

PREREQUISITES: Machine Tool Practices I

REQUIRED COURSE MATERIALS:

Textbook:	Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual:	Machine Tool Practices II, Raborn, TSTC Pub., 4th Ed.

Student Tool List **/Qty. Req'd: The same hand tools required in Machine Tool Practices I are also required for Machine Tool Practices II.

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations

4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to the Course	---	1
Safety in the Machine Shop	5	1
Gages	88	1
Lathe Parts	414	1
Lathe Accessories	394	1
Cutting Speeds and Feeds	270	1
Aligning Centers	440	1
Machining Between Centers	428	1
Knurling and Grooving	452	1
QUIZ I (over the above units)	---	1
Tapers	477	2
Threads	457	3
Using Chucks	408	1
Drilling and Boring	443	1
Milling Machines	502	1
QUIZ 2 (over the above units)	---	1
Milling Cutters	507	1
Cutting Speeds	522	1
Milling Operations	526	1
Indexing	592	2
Gears	607	1
Gear Cutting	611	1
Assembly of Jig Saw	---	3
QUIZ 3 (over the above units)	---	1
Oral Presentations*	---	6
	Total Lecture Hours	**36**

**(15-20 minute student presentations on assigned machine-related topics. These topics could include future trends or special concerns of the machine tool industry.)*

LAB OUTLINE:

Lab Topics	Contact Hrs.
Shop orientation and safety	1
Precision layout	4
Precision measuring with gage blocks and sine bar	8
Lathe work	27
Vertical milling machine work	18
Horizontal milling machine	6
Bench work	27

Assembly of machined parts	6
Testing of completed machine	6
Leaving the shop in order	5
Total Lab Hours	**108**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **PRACTICE SAFETY**
  1. Follow Safe Operating Procedures for Hand and Machine Tools
    a. Identify and understand lathe operating procedures
    b. Demonstrate safe lathe operation
    c. Identify and understand milling machine operating procedures
    d. Demonstrate safe milling machine operation

B. **APPLY MATHEMATICAL CONCEPTS**
  1. Perform Basic Trigonometric Functions
    a. Solve for unknown angles
    b. Calculate bolt hole patterns
  2. Calculate Speeds and Feeds for Machining
    a. Calculate RPM for various metals and various tools
    b. Calculate feed for various metals, tools, and depths of cut
  3. Locate Machining Points from a Datum Point
    a. Identify points using the absolute dimensioning system
    b. Identify points using the incremental dimensioning system
  4. Perform Calculations for Sine Bar and Sine Plate
    a. Calculate gage block build up for 5" sine bar
  5. Calculate for Direct, Simple, and Angular Indexing
    a. Calculate for direct indexing
    b. Calculate for simple indexing (plain)
    c. Calculate for angular indexing
    d. Use Machinery's Handbook for calculations
  6. Perform Calculations Necessary for Turning Tapers
    a. Calculate tail stock offset
    b. Determine unknowns (e.g., small and/or large diameters) for taper turning
  7. Calculate Depth of Cut on Round Surfaces
    a. Calculate depth of cut for flats to be machined on cylindrical pieces
    b. Calculate depth of cut for keyways which are machined on cylindrical pieces

C. **PERFORM CONVENTIONAL MACHINING OPERATIONS**
  1. Operate Vertical Milling Machines
    a. Demonstrate the use of all controls on the vertical milling machine
    b. Align the vertical milling machine head
    c. Select, align and use workholding devices
    d. Select milling tool holders
    e. Select milling cutters
    f. Perform all standard vertical milling operations
    g. Bore a hole using the offset boring head

- h. Machine angles using sine bar and gage blocks
- i. Setup and use special vertical mill fixtures
- j. Setup and machine dovetails
- k. Machine keyways

2. Operate Horizontal Milling Machines
    - a. Discuss the difference in plain and universal horizontal milling machines
    - b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
    - c. List several common work holding methods
    - d. Use plain milling cutters
    - e. Use side milling cutters
    - f. Use face milling cutters
3. Operate Metal Cutting Lathes
    - a. Demonstrate the use of all controls on the engine lathe
    - b. Discuss standard tools and toolholders for the lathe
    - c. Face and center drill parts correctly
    - d. Drill, ream and bore on the lathe
    - e. Turn between centers
    - f. Discuss alignment of lathe centers
    - g. Make all calculations, lathe adjustments and settings to machine UNF and UNC series threads
    - h. Discuss thread fit classifications
    - i. Describe the common tapers used in the machine shop
    - j. Discuss taper cutting and calculations for the lathe
    - k. Use HSS cutting tools
    - l. Use carbide cutting tools

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- ***A. Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. follows a schedule to complete assigned tasks on time
    2. follows a schedule to maximize laboratory resources
    3. complete a stock request form for required material
- ***B. Interpersonal:*** *Works with others*
    1. complete assigned responsibilities within the shop floor serving as a

member of the team
    2. provide individual assistance/direction to peers as requested

C. ***Information:** Acquires and uses information*
    1. read and interpret blueprints
    2. organize and apply theories of machine tool operation
    3. perform basic semi-precision and precision layout as necessary

D. ***Systems:** Understands complex inter-relationships*
    1. demonstrate knowledge of the following systems:
        a. organization of personnel and facilities on the shop floor
        b. systematic approach to the metal removal process
        c. dimensioning and measurement systems
    2. monitors and corrects performance during
        a. the machining process
        b. adjustments of individual laboratory work schedule
        c. constantly evaluating the quality of work to achieve acceptable standards

E. ***Technology:** Works with a variety of technologies*
    1. chooses procedure, tools and equipment required to produce a part
    2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

II. FOUNDATION SKILLS

A. ***Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
    1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        a. read/studies textbook
        b. studies student laboratory manual
        c. interprets blueprints and technical drawings
        d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
    2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
        a. outline the steps necessary to produce a simple machine part
        b. maintain a lecture notebook
        c. submit written responses to chapter question assignments
        d. prepare job process for lathe and mill assignments
    3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
        a. determines optimum machining speeds, feeds, and depth of cut
        b. interconverts fractions to decimal expressions
        c. keeps a running computation of individual grade
        d. calculate gage block buildup
        e. calculate for turning tapers
        f. calculate for indexing problems

4. ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. assimilate classroom instruction
    b. interpret and assimilate video instruction
    c. observe and assimilate laboratory demonstrations
    d. seek and receive individualized instruction in the laboratory
    e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
5. ***Speaking:** Organizes ideas and communicates orally*
    a. participates in classroom discussions
    b. organize ideas and communicate specific questions to the instructor
    c. verbally affirms understanding of a concept, procedure, or required skill
    d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
    e. plan and deliver a 15-20 minute oral presentation on an assigned machine-related topic

B. ***Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. decides upon a job process plan to produce a part to specifications, given constraints of available time, equipment and other resources
    b. prioritizes activities for effective use of time
2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
    a. makes daily accommodations to stay on schedule
    b. seeks additional instruction/clarification for assignment completion
    c. troubleshoots machining processes and equipment
    d. recognize problems in machining and selects appropriate corrective or preventive action
3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. visualize objects in three dimensions from engineering drawings
    b. visualize process during instructor lecture
    c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations
4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. understand that practice will improve skill
    b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. applies knowledge of principles of machining to troubleshoot process problems

        b. applies knowledge of machining process to develop a logical, sequential process plan
        c. applies knowledge of workpiece machinability, cutter characteristics and machine tool characteristics to adjust speeds and feeds

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
    1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        a. displays promptness and preparation for the day's work
        b. plans work to use time efficiently
        c. accepts responsibility for mistakes, and takes corrective and preventive actions
        d. takes initiative when needed to gain resources or assistance to complete assignments
    2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        a. takes pride in work through positive reinforcement
        b. sees self as a valued member of the group through continued contributions toward common goals
    3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
        a. assist classmates in improving technical skills
        b. share laboratory resources (machines, tools and instructor's individual attention)
    4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
        a. perform in-process quality checks on machined parts
        b. maintain a record of academic achievement (individual grade book)
        c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
    5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
        a. accept the responsibility for own actions
        b. exhibit personal honesty at all times
        c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
        d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed., McGraw Hill Publishers

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

SURVEY OF WELDING PROCESSES AND APPLICATIONS

MAST PROGRAM
COURSE SYLLABUS
SURVEY OF WELDING PROCESSES AND APPLICATIONS

Lecture hours/week: 3 **Lab hours/week: 3** **Credit hours: 4**

COURSE DESCRIPTION:

This course is a survey of shielded metal arc, gas tungsten arc, gas metal arc, flux cored arc, and submerged arc welding processes. Metal weldability and weld symbols are considered. Process safety, electrode selection, and process parameters are emphasized. Hard surfacing, using shielded metal arc and oxyacetylene processes and techniques are studied.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Oxy-Acetylene Handbook, by Linde, Union Carbide Publisher, Latest Edition
New Lessons in Arc Welding, by Lincoln Electric, Lincoln Electric Publisher, Latest Edition

Lab Manual: None Required

Student Tool List **	**Qty. Req'd.**
Oxy-acetylene cutting and welding goggles (mono) with #5 filter lens and one clear plastic lens	1 pair
Friction lighter	1
Wire brush 1" wide with long handle	1
Soap stone	2 pieces
Welder's cap	1
Welding gloves, long gauntlet	1 pair
Chipping hammer	1
Safety glasses	1 pair
Slip joint pliers	1 pair

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video, and demonstrations.

Laboratory: Hands on laboratory activities to enable the students to learn the various aspects of the welding process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to the course		1
Introduction to oxy-acetylene fusion	1	1
Oxy-acetylene welding and cutting	9	2
Introduction to mechanical and physical properties	77	1
Non-fusion welding		1
Introduction to the oxy-acetylene cutting processes		1
Test #1		1
The shielded metal arc welding process	1-7	1
Running a good quality bead in the flat position	1-21	1
Introduction to shielded metal arc welding electrodes	3-3	2
Shielded metal arc power sources	2-3	1
Test #2		1
Weld joints, weld types and weld positions	1-54	2
Introduction to fillet welds	1-56	1
Test #3		1
Introduction to gas metal arc welding and flux core arc welding	7-37	2
Short circuiting metal transfer		1
Test #4		1
Power sources for GMAW and FCAW		1
SMAW and FCAW filler metal transfer modes		1
Test #5		1
Shielding gases used with the GMAW process	7-37	1
Shielding gases used with the FCAW process		1
Test #6		1
Introduction to gas tungsten arc welding		2
Power sources for GTAW		1

GTAW electrodes		1
Test #7		1
Introduction to submerged arc welding and techniques	7-69	1
Submerged arc welding processes		1
Test #8		1
	Total Lecture Hours	**36**

LAB OUTLINE:

	Lab Topics	Contact Hrs.
1	**The Oxy-Acetylene Welding and Cutting Process**	9
	Demonstration of setting up and break down of equipment	
	A. Welding beads on plate	
	(1) Flat position	
	(2) Without and with filler	
	B. Square butt joints	
	(1) Flat and vertical position	
	(2) With filler material	
	C. Brazing beads on plate	
	(1) Flat position	
	(2) With filler material	
	D. Brazing square butt joint	
	(1) Flat and vertical position	
	(2) With filler	
	E. Oxy-acetylene cutting	
	(1) Cutting to a straight line	
2	**The Shielded Metal Arc Welding Process (SMAW)**	9
	A. Welding beads on plate	
	(1) E6010, E6011 and/or E7018 dependent on availability	
	(2) Flat, horizontal and vertical	
	B. Welding tee joint	
	(1) E6010, E6011 and/or E7018 dependent on availability	
	(2) Flat, horizontal and vertical	
3	**The Gas Metal Arc Welding and Flux Core Welding Processes (GMAW)**	6
	A. Set up 3 machines each process	
	B. Welding beads on plate, both processes	
	(1) Have hands on with observers at each station	
	C. Demonstration of GMAW spot welder	
4	**The Gas Tungsten Arc Welding Process (GTAW)**	6
	A. Set up machines for welding steel and aluminum (2 or 3 each)	
	B. Welding beads on plate steel	
	(1) Have hands on with observers	
	C. Welding bead on plate aluminum	
	(2) Have hands on with observers	
5	**The Submerged Arc Welding Process**	6
	A. Demonstrate beads on plate	
	B. Demonstrate running beads roll position	

C. Let students have hands on and observation

Total Lab Hours **36**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

- A. **PRACTICE SAFETY**
  - 1. Use Protective Equipment
    - a. Wear protective safety clothing as required when welding
  - 2. Follow Safe Operating Procedures for Welding/Cutting Machines
    - a. Identify and understand safe welding procedures
    - b. Demonstrate safe welding procedures
- B. **PERFORM WELDING OPERATIONS**
  - 1. Weld With Shielded Metal Arc Welding (SMAW) Process
    - a. Identify factors for welding electrode selection
    - b. Adjust welding amperage setting for each application
    - c. Demonstrate proper use of safety equipment
    - d. Weld beads on plate (flat and horizontal)
    - e. Weld tee joints (flat and horizontal)
    - f. Identify weld inspection factors and techniques
  - 2. Weld/Cut With Oxy-acetylene
    - a. Setup and break down the oxy-acetylene welding/cutting station
    - b. Properly adjust oxy-acetylene regulators
    - c. Identify factors that determine torch welding and cutting tip selection
    - d. Demonstrate routine torch maintenance procedures
    - e. Weld beads on plate (with and without filler) in the flat and horizontal positions
    - f. Weld square groove butt joints in the flat and horizontal positions
    - g. Braze weld beads on plate in the flat position
    - h. Make square cuts to a straight line with the cutting torch
    - i. Demonstrate proper use of safety equipment
  - 3. Weld With Gas Tungsten Arc Welding (GTAW) (Heliarc)
    - a. Set up GTAW welder for welding steel
    - b. Set up GTAW welder for welding aluminum
    - c. Weld beads on plate (steel) with appropriate filler rod in the flat position
    - d. Weld beads on plate (aluminum) with appropriate filler rod in the flat position
    - e. Weld lap joints in the horizontal position on steel plate
    - f. Weld lap joints in the horizontal position on aluminum plate
  - 4. Weld With Gas Metal Arc Welding (GMAW)/(MIG)
    - a. Set up machine for gas metal arc welding
    - b. Set up machine for flux cored arc welding
    - c. Weld beads on plate with gas metal arc welding system in the flat position
    - d. Weld beads on plate with flux cored welding system in the flat position
    - e. Weld lap joints on steel plate with the gas metal arc welding system in the horizontal position

    f. Weld lap joints on steel plate with the flux cored arc welding system in the horizontal position

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
    - *A.* ***Resources:** Identifies, organizes, plans, and allocates resources*
        1. follows a schedule to complete assigned tasks on time
        2. follows a schedule to maximize laboratory resources
        3. complete a tool crib request form for required materials and supplies
    - *B.* ***Interpersonal:** Works with others*
        1. complete assigned responsibilities within the welding lab serving as a member of the team
        2. provide individual assistance/direction to peers as requested
        3. works well with all members of the class
    - *C.* ***Information:** Acquires and uses information*
        1. read and interpret weld symbols
        2. organize and apply theories of welding and cutting
    - *D.* ***Systems:** Understands complex inter-relationships*
        1. demonstrate knowledge of the following systems:
            - a. organization of personnel and facilities on the shop floor
            - b. systematic approach to the cutting and welding processes
            - c. welding rod classification and match to various metals
            - d. systematic organization of training materials
        2. monitors and corrects performance during
            - a. the welding process
            - b. adjustments of individual laboratory work schedule
            - c. constantly evaluating the quality of work to achieve acceptable standards
    - *E.* ***Technology:** Works with a variety of technologies*
        1. chooses procedure, tools and equipment required to perform the welding process
        2. applies appropriate procedures and uses appropriate tools and equipment to produce a weld to acceptable standards
        3. maintains and troubleshoots equipment
            - a. applies appropriate preventative maintenance

        - b. when using equipment
        - c. reports all malfunctions of equipment to supervisor/instructor

II. FOUNDATION SKILLS

- *A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
    - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. read/studies textbook
        - b. studies student laboratory manual
        - c. interprets welding symbols
        - d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
    - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
        - a. outline the steps necessary to set up, properly adjust and weld/cut using different types of welding equipment
        - b. maintain a lecture notebook
    - *3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
        - a. keeps a running computation of individual grade
    - *4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
        - a. assimilate classroom instruction
        - b. interpret and assimilate video instruction
        - c. observe and assimilate laboratory demonstrations
        - d. seek and receive individualized instruction in the laboratory
        - e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
    - *5.* ***Speaking:*** *Organizes ideas and communicates orally*
        - a. participates in classroom discussions
        - b. organize ideas and communicate specific questions to the instructor
        - c. verbally affirms understanding of a concept, procedure, or required skill
        - d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
- *B.* ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
    - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. analyzes requirements and makes decisions to select appropriate welding process, equipment, materials, fixturing, and protective equipment
        - b. prioritizes activities for effective use of time

2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
    a. makes daily accommodations to stay on schedule
    b. seeks additional instruction/clarification for assignment completion
    c. troubleshoots welding problems and makes process adjustments to correct
3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. visualize process during instructor lecture
    b. visualize the relative motions between welding rod and workpiece to generate desired weld patterns and weld strength as required
4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. understand that practice will improve skill
    b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. applies knowledge of material characteristics, job requirements, and welding processes to perform assignments
    b. applies knowledge of material characteristics, job requirements, and welding processes to troubleshoot and/or imporve the welding process

C. ***Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    a. displays promptness and preparation for the day's work
    b. plans work to use time efficiently
    c. accepts responsibility for mistakes, and takes corrective and preventive actions
    d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    a. takes pride in work through positive reinforcement
    b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. assist classmates in improving technical skills
    b. share laboratory resources (welding machines, tools and instructor's individual attention)
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. perform in-process quality checks on weldments
    b. maintain a record of academic achievement (individual grade book)

    c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. accept the responsibility for own actions
    b. exhibit personal honesty at all times
    c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
    d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Welding Technology Today, Principles and Practices. Stinchcomb, Craig;: Prentice Hall Inc., New Jersey 1989
3. Welder Handbook. W-100 E-1 Corp., Publication #51077, Nov., 1995
4. Hobart Audio - Visual Training Program
5. Miller Audio - Visual Training Program

***M**achine Tool **A**dvanced **S**kills*
***T**echnology Program*

MAST

COURSE SYLLABUS

MACHINE TOOL PRACTICES III

Prerequisite: MACHINE TOOL PRACTICES II

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL PRACTICES III

Lecture hours/week: 3 **Lab hours/week: 12** **Credit hours: 7**

COURSE DESCRIPTION:

The students will be required to apply knowledge and skills gained in Machine Tool Practices I and II to make necessary calculations, select desired machine tools, and plan machining operations and sequences to produce the required work from working drawings and sketches with a minimum of instructor prepared guidelines.

Special emphasis will be placed on the identification, heat treatment, machinability and other properties of various metals which are used in manufacturing. Students will also learn the correct setup and operation of different grinding machines used in the machine shop.

PREREQUISITES: Machine Tool Practices I and II

REQUIRED COURSE MATERIALS:

Textbook:	Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual:	None Required

Student Tool List **

In addition to the tools required for Machine Tool Practices I and II the students will need the following:

	Qty. Req'd.
Soft face hammer	1
Drill sharpening gage	1
Edge finder	1
Calculator w/trig functions	1
12" hacksaw & blade	1
Shop towels	1 roll

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Course Introduction	---	1
Introduction of Metal Lathe Project	Handouts	1
Selection and Identification of Ferrous Steels	193	1
Selection and Identification of Nonferrous Steels	199	1
Hardness Testing	218	1
Hardening, Case Hardening and Tempering	206	1
Annealing, Normalizing and Stress Relieving	218	1
QUIZ I...over the above topics		1
Grinding and Abrasive Machining Processes	617	1
Selection and Identification of Grinding Wheels	630	1
Trueing, Dressing and Balancing of Grinding Wheels	637	1
Sharpening Hand Tools on the Pedestal Grinder	79	1
Grinding Fluids	642	1
Horizontal Spindle w/Reciprocating Table Surface Grinders	646	1
Work Holding on the Surface Grinder	649	1
Using the Surface Grinder	653	1
Grinding Surfaces at Right Angles	Handout	1
Problems and Solutions in Surface Grinding	660	1
Center-Type Cylindrical Grinders	663	1
Using the Cylindrical Grinder	669	1
Universal Tool and Cutter Grinders	673	1
QUIZ II...over the above topics		1

Grinding Internal Surfaces	Handout	1
Grinding Radii and Angles	Handout	1
Form Grinding	Handout	1
Grinding with Superabrasives	Handout	1
QUIZ III...over the above topics		1
	Total Lecture Hours	**27**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Heat Treating Furnace Operation	3
Use of the Rockwell Hardness Tester	6
Hardening and Tempering Ferrous Metals	6
Use of the Surface Grinder	18
Machining Components for the Metal Lathe Project	111
Total Lab Hours	**144**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **PRACTICE SAFETY**
  1. Follow Safe Operating Procedures for Hand and Machine Tools
    a. Identify and understand safe heat treatment procedures
    b. Demonstrate safe heat treatment procedures
    c. Identify and understand safe grinding procedures
    d. Demonstrate safe grinding procedures

B. **RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES**
  1. Identify Materials With Desired Properties
    a. Discuss classification system for metals
    b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
  2. Describe the Heat Treating Process
    a. Discuss the reasons for heat treating
    b. Discuss the time/temperature chart
    c. List the different quenching mediums
    d. Estimate metal heat temperature by color
    e. List reasons for stress relieving workpieces
    f. Describe surface hardening processes
  3. Test Metal Samples for Hardness
    a. Perform spark test to test for metal hardness
    b. Perform Rockwell hardness tests

C. **PERFORM CONVENTIONAL MACHINING OPERATIONS**
  1. Operate Grinding/Abrasive Machines
    a. Discuss the selection and identification of grinding wheels

  b. Inspect, mount, true, dress, and balance grinding wheels
  c. Discuss the selection of grinding fluids
  d. Operate horizontal spindle reciprocating table surface grinders
  e. Discuss common problems and solutions in surface grinding

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
  A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. plans work to complete assigned tasks on time
    2. complete a stock request form for required material
  B. ***Interpersonal:*** *Works with others*
    1. complete assigned responsibilities while on the shop floor serving as a member of the team
    2. provide individual assistance/direction to peers as requested
  C. ***Information:*** *Acquires and uses information*
    1. read and interpret blueprints
    2. organize and apply theories of heat treatment
    3. organize and apply theories of grinding
  D. ***Systems:*** *Understands complex inter-relationships*
    1. demonstrate knowledge of the following systems:
      a. organization of personnel and facilities on the shop floor
      b. understand the relationship of carbon content, the time-temperature chart, and different quenching mediums as they apply to the heat treatment processes
      c. codes for designating grinding wheel characteristics
    2. monitors and corrects performance during
      a. the heat treatment process
      b. the grinding process
      c. constantly evaluating the quality of work to achieve acceptable standards
  E. ***Technology:*** *Works with a variety of technologies*
    1. chooses procedure, tools and equipment required to produce a part
    2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

II. FOUNDATION SKILLS

- *A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. read/studies textbook
    - b. interprets blueprints and technical drawings
    - c. follow a daily laboratory schedule to maintain appropriate time-line and product completion
  - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. prepare a process plan for parts to be heat-treated and ground
    - b. maintain a lecture notebook
    - c. submit written responses to chapter question assignments
  - *3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. determines optimum machining speeds, feeds, and depth of cut
    - b. keeps a running computation of individual grade
  - *4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. assimilate classroom instruction
    - b. interpret and assimilate video instruction
    - c. observe and assimilate laboratory demonstrations
    - d. seek and receive individualized instruction in the laboratory
    - e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
  - *5.* ***Speaking:*** *Organizes ideas and communicates orally*
    - a. participates in classroom discussions
    - b. organize ideas and communicate specific questions to the instructor
    - c. verbally affirms understanding of a concept, procedure, or required skill
    - d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
- *B.* ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
  - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. considers heat treating requirements for a part, and selects an appropriate course of action within the constraints of time and available equipment
    - b. inspects a heat treated part and selects appropriate equipment to grind to finish size

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. makes daily accommodations to stay on schedule
    b. seeks additional instruction/clarification for assignment completion
    c. troubleshoots heat treating processes and equipment
    d. recognize problems in grinding and selects appropriate corrective or preventive action
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. visualize process during instructor lecture
    b. visualize the relative motions between grinding wheel and workpiece to generate desired surface finish and part dimensions
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. understand that practice will improve skill
    b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. applies knowledge of heat treating, material characteristics, and part geometry to predict distortion during heat treatment
    b. applies knowledge of material characteristics, work requirements, and grinding wheel characteristics to select the best grinding wheel for the job

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. displays promptness and preparation for the day's work
    b. plans work to use time efficiently
    c. accepts responsibility for mistakes, and takes corrective and preventive actions
    d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. takes pride in work through positive reinforcement
    b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. assist classmates in improving technical skills
    b. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. perform in-process hardness tests on heat-treated parts

    b. perform in-process dimensional checks and surface finish checks while grinding to print specifications
    c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. accept the responsibility for own actions
    b. exhibit personal honesty at all times
    c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
    d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers

***M**achine Tool **A**dvanced **S**kills*
***T**echnology Program*

MAST

COURSE SYLLABUS

MANUFACTURING PROCESSES

MAST PROGRAM
COURSE SYLLABUS
MANUFACTURING PROCESSES

Lecture hours/week: 3 **Lab hours/week:** 3 **Credit hours:** 4

COURSE DESCRIPTION:

Essential studies into the processes and materials for manufacturing, including metal casting, hot and cold forming of steel, powder metallurgy and plastics. Analysis of newer processes such as electrical discharge machining, chemical machining, and ultra-sonic machining; with a emphasis on the economical manufacturing of products.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Modern Materials and Manufacturing Processes, John E. Neeley & Richard R. Kibbe, Prentice Hall Career & Technology, Englewood Cliffs, N.J., 1987

Lab Manual: None Required

Student Tool List ****:** Safety glasses

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will consist of "hands-on" activities. Students will operate various conventional metalworking machines to manufacture a product.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy

7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to the Course		1
The Manufacturing Industry	21	3
Material Resource Planning (MRP)	25	2
Processing of Metals: Casting	7	3
Processing of Metals: Hot Working	8	3
Processing of Metals: Cold Working	9	3
QUIZ I		1
Powder Metallurgy	10	2
Non-traditional Machining Processes	13	3
Plastics & Composite Processes	15	4
QUIZ II		1
Joining Processes	14	3
Corrosion & Protection for Materials	16	1
Design, Tooling & Production Lines	18	5
QUIZ III		—
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Lab Orientation and Safety	2
Lab Sheet #1 - Stock preparation; measure (semi-precision), shear and debur	3
Lab Sheet #2 - Layout, drill, ream and debur holes	3
Lab Sheet #3 - Metal forming (bending) and countersinking holes	3
Lab Sheet #4 - Metal joining (welding), stress relieving and sawing	3
Mid-term project evaluation and rework	2
Lab Sheet #5 - Surface preparation (sand blast) and surface finish (paint)	3
CNC stock preparation	2
CNC Machining Demonstration and CIM Lab Demonstration	3
Lab Sheet #6 - Component sub-assembly and precision machining activity	3
Lab Sheet #7 - Sub-assembly manufacture (handle)	3
Lab Sheet #8 - Final assembly and test (final project evaluation)	3
Lab clean-up	3
Total Lab Hours	**36**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safe Operating Procedures for Hand and Machine Tools
    a. Identify and understand safe machine operating procedures

        b. Demonstrate safe machine operation

B. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Describe the Relationship of Engineering Drawings to Planning
    a. Discuss production schedule
    b. Discuss Material Resource Planning (MRP)
    c. Discuss inventory control records
    d. Discuss shop floor routing documents
2. Use Standards to Verify Requirements
    a. Discuss the purpose of standards
    b. Discuss source locations for standards
3. Analyze Bill of Materials (BOM)
    a. Discuss components found on BOM
    b. Determine materials needed to produce the part
    c. Determine quantities necessary to produce the part
    d. Submit completed stock request form as required
    e. Submit completed tool request form as needed

C. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
    a. Discuss classification system for metals
    b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
1. follows a schedule to complete assigned tasks on time
2. follows a schedule to maximize laboratory resources
3. determine the initial cost of materials and "value added" as result of processing

B. ***Interpersonal:*** *Works with others*
1. complete assigned responsibilities within the manufacturing lab serving as a member of the team
2. provide individual assistance/direction to peers as requested

- C. *Information: Acquires and uses information*
  - 1. read and interpret blueprints
  - 2. organize and apply theories of manufacturing processes
  - 3. perform basic semi-precision and precision layout as necessary
- D. *Systems: Understands complex inter-relationships*
  - 1. demonstrate knowledge of the following systems:
    - a. organization of personnel and facilities in the manufacturing lab
    - b. systematic approach to the production process
    - c. dimensioning and measurement systems
  - 2. monitors and corrects performance during
    - a. the manufacturing process
    - b. adjustments of individual laboratory work schedule
    - c. constantly evaluating the quality of work to achieve acceptable standards
- E. *Technology: Works with a variety of technologies*
  - 1. chooses procedure, tools and equipment required to fabricate a product
  - 2. applies appropriate procedures and uses appropriate tools and equipment to fabricate a part to referenced engineering standards

II. FOUNDATION SKILLS

- A. *Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - 1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. read/studies textbook
    - b. studies student laboratory exercises
    - c. interprets blueprints and technical drawings
    - d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
  - 2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. outline the steps necessary to produce simple product
    - b. maintain a lecture notebook
    - c. submit written responses to chapter question assignments
  - 3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. calculate bend allowances for sheet metal and metal plate
    - b. keeps a running computation of individual grade
  - 4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. assimilate classroom instruction
    - b. interpret and assimilate video instruction
    - c. observe and assimilate laboratory demonstrations
    - d. seek and receive individualized instruction in the laboratory

      - e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
   - 5. *Speaking: Organizes ideas and communicates orally*
      - a. participates in classroom discussions
      - b. organize ideas and communicate specific questions to the instructor
      - c. verbally affirms understanding of a concept, procedure, or required skill
      - d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
- *B.* ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
   - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
      - a. applies knowledge of process and materials to select appropriate material and process for safe and economical service in a given application
      - b. prioritizes activities for effective use of time
   - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
      - a. makes daily accommodations to stay on schedule
      - b. seeks additional instruction/clarification for assignment completion
      - c. troubleshoots manufacturing processes and equipment
      - d. recognize problems in manufacturing and selects appropriate corrective or preventive action
   - *3.* ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
      - a. visualize objects in three dimensions from engineering drawings
      - b. visualize process during instructor lecture
      - c. visualize the capabilities of various manufacturing processes and machine tools to generate desired features in raw stock in order to manufacture a simple product
   - *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
      - a. understand that practice will improve skill
      - b. asks questions or seeks help when uncertain about new skills or knowledge
   - *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
      - a. apply general understanding of process and material characteristics to determine the process by which a part or piece of stock has been made
      - b. applies knowledge of manufacturing materials and processes to develop a logical, sequential process plan
      - c. apply broad understanding of processes, materials, product requirements, and manufacturing economics to consider and apply new or alternative techniques to reduce costs, save time and improve quality

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
  1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
     a. displays promptness and preparation for the day's work
     b. plans work to use time efficiently
     c. accepts responsibility for mistakes, and takes corrective and preventive actions
     d. takes initiative when needed to gain resources or assistance to complete assignments
  2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
     a. takes pride in work through positive reinforcement
     b. sees self as a valued member of the group through continued contributions toward common goals
  3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
     a. assist classmates in improving technical skills
     b. share laboratory resources (machines, tools and instructor's individual attention)
  4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
     a. perform in-process quality checks on manufactured component parts
     b. maintain a record of academic achievement (individual grade book)
     c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
  5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
     a. accept the responsibility for own actions
     b. exhibit personal honesty at all times
     c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
     d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

INTRODUCTION TO CNC

MAST PROGRAM
COURSE SYLLABUS
INTRODUCTION TO CNC

Lecture hours/week: 2 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Gives the student a basic knowledge of numerically controlled (NC) and computer numerically controlled (CNC) machine tools. Teaches differences between conventional and numerically controlled machines. Emphasis will be placed on safety of CNC machines. Principles of programming, tooling, setup will be studied.

Included in the course will be a study of manual CNC programming techniques. Related topics to be discussed include: Cartesian coordinates, absolute/incremental, word address, G & M codes, fixed cycles and CNC systems.

PREREQUISITES: Machine Tool Practices I and II and Occupational Math

REQUIRED COURSE MATERIALS:

Textbook: Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual: Supplied by the instructor.

Student Tool List **: Required tools will be found on the basic Machine Tool Practices I Tool List.

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations

Laboratory: Laboratory will be a "hands-on" activities relating to CNC programming

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments

5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

NOTE: *THE PILOT CURRICULUM WAS DEVELOPED AND TESTED IN A LABORATORY THAT WAS EQUIPPED WITH A FADAL VMC-20 VERTICAL MACHINING CENTER, AN OKUMA LB-15 TURNING CENTER AND A COMPUTER LAB LOADED WITH THE "SMARTCAM" SOFTWARE PACKAGE. NO TEXTBOOK WAS FOUND TO INCLUDE ALL THREE OF THESE IMPORTANT LAB COMPONENTS; THEREFORE, THE FACTORY SUPPLIED MANUALS WERE USED IN THE DEVELOPMENT AND PRESENTATION OF THE TOPICS COVERED IN THIS COURSE.*

Lecture Topics	Contact Hrs.
CNC Overview	3
Description of CNC	
Job opportunities in the CNC field	
Employability skills in CNC	
Working Safely with CNC machines	
The Structure of a CNC System	3
CNC vs. conventional machining terminology	
5 Questions to answer before programming starts	
Cartesian Coordinate system	
Process Planning (Mill)	3
Interpreting a part print	
Creating a job sheet from a part print	
Introduction to **SMARTCAM'S** Job Plan module	
Entering tool information into the Job Plan	
Programming Format (Mill)	6
Basic CNC code structure (FADAL)	
Starting a CNC Program	
Machining examples	
Ending a CNC program	
Introduction to **SMARTCAM'S** Edit Plus module and Tape-to-Shape capabilities	
Using **SMARTCAM** to simulate machine tool movements	
Programming CNC Machining Operations (Mill)	3
Straight milling	
Drilling	
Circular milling	
Process Planning (Lathe)	3
CNC lathe coordinate systems	
Carbide tooling inserts for CNC lathes	
Process planning (lathes)	

Entering tool information into the Job Plan	
Programming the CNC Lathe	3
Basic program structure	
Turning, Facing, Boring and Drilling	—
Total Lecture Hours	**24**

LAB OUTLINE:

Lab Topics	Contact Hrs.
CNC Lab Organization and Safety	3
Identification of Major CNC Components	3
CNC (Mill) Tooling Systems	3
Introduction to SMARTCAM Programming Software	6
Job Plan, Applications and Edit Plus Modules	
Programming CNC Machining Center	18
Basic Program Structure	
Linear Milling, Drilling, Circular Milling, and Canned Cycles	
CNC (Lathe) Tooling Systems	3
Programming CNC Lathes	6
Basic Program Structure	
Turning, Facing, Boring, Drilling, and Threading	
Final Project	6
Total Lab Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **APPLY MATHEMATICAL CONCEPTS**
  1. Perform Basic Trigonometric Functions
    a. Solve for unknown angles
    b. Solve for unknown sides
    c. Calculate bolt hole patterns
  2. Calculate Speeds and Feeds for Machining
    a. Calculate RPM for various metals and various tools
    b. Write CNC code for programming RPM
    c. Calculate feed for various metals, tools, and depths of cut
    d. Write CNC code for programming feed and depth of cut
  3. Locate Machining Points from a Datum Point
    a. Identify points using the Cartesian coordinate system
    b. Identify points using the polar coordinate system
    c. Identify points using the absolute dimensioning system
    d. Identify points using the incremental dimensioning system

B. **PERFORM ADVANCED MACHINING PROCESSES**
  1. Prepare and Plan For CNC Machining Operations
    a. Read and interpret blueprints
    b. Plan CNC machining operations

    - c. Calculate speeds, feeds, and depth of cut for various CNC machine applications
    - d. Determine proper cutting fluids/coolants for CNC machining
    - e. Use the Machinery's Handbook as a reference for CNC machine applications
- 2. Program CNC Machines
    - a. Identify CNC applications
    - b. List various types of CNC machines
    - c. Discuss CNC machine control systems
    - d. Describe absolute and incremental coordinate systems
    - e. Plan and write programs for CNC mills
    - f. Plan and write programs for CNC lathes
    - g. Verify CNC programs using computer software
    - h. Edit CNC programs

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    - 1. follows a schedule to complete assigned tasks on time
    - 2. follows a schedule to maximize laboratory resources
- *B.* ***Interpersonal:*** *Works with others*
    - 1. complete assigned responsibilities within the CNC lab serving as a member of the team
    - 2. provide individual assistance/direction to peers as requested
- *C.* ***Information:*** *Acquires and uses information*
    - 1. read and interpret blueprints
    - 2. read and interpret CNC machine programming manuals
    - 3. read and write CNC machine code
- *D.* ***Systems:*** *Understands complex inter-relationships*
    - 1. demonstrate knowledge of the following systems:
        - a. organization of personnel and facilities in the CNC lab
        - b. systematic approach to the metal removal process using CNC
        - c. dimensioning and measurement systems

- d. relationships among the machine tool, its control system, and the program
- 2. monitors and corrects performance during
  - a. adjustments of individual laboratory work schedule
  - b. constantly evaluating the quality of work to achieve acceptable standards
- E. ***Technology:** Works with a variety of technologies*
  - 1. chooses procedure required to program a part using CNC
  - 2. applies appropriate procedures to program a part using CNC

II. FOUNDATION SKILLS

- A. ***Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
  - 1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. read/studies CNC machine programming manuals
    - b. interprets blueprints and technical drawings
    - c. follow a daily laboratory schedule to maintain appropriate time-line and product completion
  - 2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. outline the steps necessary to program and produce a machine part using CNC
    - b. maintain a lecture notebook
    - c. write CNC programs for CNC mills and CNC lathes
  - 3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. determines optimum machining speeds, feeds, and depth of cut
    - b. interconverts fractions to decimal expressions
    - c. keeps a running computation of individual grade
    - d. identify machining points using the Cartesian coordinate system
  - 4. ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. assimilate classroom instruction
    - b. interpret and assimilate video instruction
    - c. observe and assimilate laboratory demonstrations
    - d. seek and receive individualized instruction in the laboratory
    - e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
  - 5. ***Speaking:** Organizes ideas and communicates orally*
    - a. participates in classroom discussions
    - b. organize ideas and communicate specific questions to the instructor
    - c. verbally affirms understanding of a concept, procedure, or required skill

d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the CNC lab

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

   a. identifies requirements and uses knowledge and judgement to select a best CNC machining approach from among available alternatives

   b. applies knowledge of processes and requirements to confirm that the process is functioning properly, or to improve the process

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

   a. makes daily accommodations to stay on schedule

   b. seeks additional instruction/clarification for assignment completion

   c. troubleshoots and debugs CNC programs

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

   a. visualize objects in three dimensions from engineering drawings

   b. visualize process during instructor lecture

   c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations

   d. visualize cutter path and position of clamps and workholding devices while preparing CNC programs

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

   a. understand that practice will improve skill

   b. asks questions or seeks help when uncertain about new skills or knowledge

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

   a. applies knowledge of machining processes, tooling, and materials to optimize CNC programming

   b. applies knowledge of programming system to develop CNC programs in a logical, efficient manner

   c. applies knowledge of workpiece machinability, cutter characteristics and machine tool characteristics to program optimum speeds and feeds

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

   a. displays promptness and preparation for the day's work

   b. plans work to use time efficiently

   c. accepts responsibility for mistakes, and takes corrective and preventive actions

    d. takes initiative when needed to gain resources or assistance to complete assignments

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. takes pride in work through positive reinforcement
    b. sees self as a valued member of the group through continued contributions toward common goals
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. assist classmates in improving technical skills
    b. share laboratory resources (machines, tools, computers and instructor's individual attention)
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. maintain a record of academic achievement (individual grade book)
    b. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. accept the responsibility for own actions
    b. exhibit personal honesty at all times
    c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
    d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers
3. Computer Numerical Control by Warren S. Seams, Delmar Publishers

Machine Tool Advanced Skills
Technology Program

MAST

COURSE SYLLABUS

MACHINE TOOL PRACTICES IV

Prerequisite: MACHINE TOOL PRACTICES III

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL PRACTICES IV

Lecture hours/week: 3 **Lab hours/week: 15** **Credit hours: 8**

COURSE DESCRIPTION:

This course is designed for students who have successfully completed Machine Tool Practices I, II and III. This course will cover the machining skills they have mastered in their first three quarters at an advanced level. Additional skills such as production machining, production machine set up and fixturing along with working with working with assembly drawings will be covered.

Students will be challenged to further refine and hone their machining skills which were presented in earlier machining courses. Students will be encouraged to strive for mastery of their machining skills and to increase their knowledge about metal working procedures.

Emphasis will be placed on developing the skills and attitudes which are sought by employers in the machine trade industries. Topics which will be discussed are: quality in manufacturing, the high cost of scrap, the value added to a product by the machinist, and the machinist's role in the overall manufacturing process.

Students will be introduced to more complex machining operations through the production of several parts that are required for the assembly of their final project. Students will not only be expected to perform all machining operations but also plan, layout, and set up any machines necessary to produce the part.

Lab activities will be performed in more of a "real life" machine shop atmosphere with the instructor serving in the role of the supervisor. Students will be challenged to become problem solvers and team players while in the machine shop. A large portion of this class is dedicated to molding the students into the type of employees which are sought by industry...machinists with good basic machining skills coupled with a positive attitude and a willingness to learn.

PREREQUISITES: **Machine Tool Practices I, II and III**

REQUIRED COURSE MATERIALS:

Textbook:	Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual:	Instructor Prepared Lessons/Modules

REQUIRED COURSE MATERIALS:

Student Tool List ****:** Tools are the same as those used in Machine Tool Practices I, II and III.

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Course Introduction	---	1
Continuation of the Metal Lathe Project	Handout	3
Quality in Manufacturing...Importance	Module MET-L1	1
Implementing Concepts of Quality in the Workplace	Module MET-L2	1
Principles and Tools of Continuous Improvement	Module MET-L3	5
What is "ISO 9000"?	Handout	1
QUIZ I...over the above topics		1
How Companies Make Their Money...	Handout	1
Direct vs. Indirect Costs	Handout	1
Company Expectations of Their Employees	Handout	1
Employee Expectations of the Company	Handout	1
QUIZ II...over the above topics		1
Introduction to Electrical Discharge Machining	Module MET-G6	1
EDM Electrodes...Roughing and Finishing	Handout	3
Set up and Operation of the Sinker EDM	Demonstration	6
Introduction to 3R Tooling	Handout	1
Set up and Operation of the Wire EDM	Demonstration	6
QUIZ III...over the above topics		1
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Set Up and Operation of Sinker EDM	10
Set Up and Operation of Wire EDM	10
Machining of Most Advanced Metal Lathe Components	120
Inspect Components for the Metal Lathe Project	10
Assembly/Test the Metal Lathe Project	30
Total Lab Hours	**180**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **PRACTICE SAFETY**
  1. Follow Safe Operating Procedures for Hand and Machine Tools
    a. Identify and understand safe heat treatment procedures
    b. Demonstrate safe heat treatment procedures
    c. Identify and understand safe grinding procedures
    d. Demonstrate safe grinding procedures

B. **PERFORM ADVANCED MACHINING PROCESSES**
  1. Operate Electrical Discharge Machines
    a. Discuss the EDM process
    b. List advantages and disadvantages of the EDM process
    c. Identify electrode materials
    d. Machine EDM electrodes
    e. Setup and operate sinker EDM machine
    f. Calculate overburn
    g. Identify generator setting of machine
    h. Choose proper techniques for flushing
    i. Setup and operate wire EDM machine

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
  A. Resources: Identifies, organizes, plans, and allocates resources
    1. plans lab work to complete assigned tasks on time

2. complete a stock request form for required material
3. determine the initial cost of materials and "value added" as result of machining

B. ***Interpersonal:*** *Works with others*

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested

C. ***Information:*** *Acquires and uses information*

1. read and interpret blueprints
2. organize and apply theories of machine tool operation
3. perform basic semi-precision and precision layout as necessary

D. ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
    a. organization of personnel and facilities on the shop floor
    b. systematic approach to the metal removal process through the EDM process
    c. dimensioning and measurement systems
2. monitors and corrects performance during
    a. the machining process
    b. adjustments of individual laboratory work schedule
    c. constantly evaluating the quality of work to achieve acceptable standards

E. ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. read/studies classroom handouts
    c. interprets blueprints and technical drawings
    d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. maintain a lecture notebook
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. determines optimum machining speeds, feeds, and depth of cut
    b. interconverts fractions to decimal expressions
    c. keeps a running computation of individual grade
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. assimilate classroom instruction

b. interpret and assimilate video instruction

c. observe and assimilate laboratory demonstrations

d. seek and receive individualized instruction in the laboratory

e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics

5. ***Speaking:** Organizes ideas and communicates orally*

a. participates in classroom discussions

b. organize ideas and communicate specific questions to the instructor

c. verbally affirms understanding of a concept, procedure, or required skill

d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory

B. ***Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. considers and applies quality improvements to machining processes

b. considers and applies actions to reduce costs of machining processes

2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*

a. makes daily accommodations to stay on schedule

b. seeks additional instruction/clarification for assignment completion

c. troubleshoots machining processes and equipment

d. recognize problems in machining and selects appropriate corrective or preventive action

e. identifies quality problems and takes appropriate actions to correct and prevent the problems

3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. visualize objects in three dimensions from engineering drawings

b. visualize process during instructor lecture

c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations

4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*

a. understand that practice will improve skill

b. asks questions or seeks help when uncertain about new skills or knowledge

5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. applies knowledge of principles of EDM to troubleshoot process problems or to improve the process

b. applies knowledge of EDM process to develop a logical, sequential process plan

        c. applies knowledge of systems involving people, planning, materials, processing, routing and handling, and quality principles to identify the root cause of a quality problem

C. ***Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    a. displays promptness and preparation for the day's work
    b. plans work to use time efficiently
    c. accepts responsibility for mistakes, and takes corrective and preventive actions
    d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    a. takes pride in work through positive reinforcement
    b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. assist classmates in improving technical skills
    b. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. perform in-process quality checks on machined parts
    b. maintain a record of academic achievement (individual grade book)
    c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. ***Integrity/Honesty:** Choose ethical courses of action*
    a. accept the responsibility for own actions
    b. exhibit personal honesty at all times
    c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
    d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers

Machine Tool Advanced Skills
Technology Program

MAST

COURSE SYLLABUS

ADVANCED CNC

Prerequisite: INTRODUCTION TO CNC

MAST PROGRAM
COURSE SYLLABUS
ADVANCED CNC

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

Continuation of Introduction to CNC. Extends basic principles of numerical control to actual machine operations. Basic descriptions of Computer Numerical Control and step-by-step procedures for planning and preparing a computer-assisted program are given. CNC lathe and CNC milling machine applications are utilized for machining of complete units or student laboratory projects.

Student activities are planned to focus on the safe setup and operation of the CNC mill center and the CNC lathe. Students will learn the basics of IGF programming using the Okuma CNC lathe. Students will also be introduced to the SMARTCAM programming system with special emphasis on job planning and 3-axis milling applications.

PREREQUISITES: **INTRODUCTION TO CNC**

REQUIRED COURSE MATERIALS:

Textbook: None
Lab Manual: None

Student Tool List ****:** Tools will be the same as required for Introduction to CNC

** A complete list of recommended capital equipment, tools and supplies (to be furnished by the school) may be found in Tab 5 of this volume.

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations

Laboratory: Laboratory activities will be strictly hands on with approximately 1/3 time spent on the CNC lathe, 1/3 time on the CNC mill and 1/3 time using the SMARTCAM computer lab.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments

2. apply theory to laboratory assignments
3. perform on written, oral, or practical examinations
4. perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

NOTE: *THE PILOT CURRICULUM WAS DEVELOPED AND TESTED IN A LABORATORY THAT WAS EQUIPPED WITH A FADAL VMC-20 VERTICAL MACHINING CENTER, AN OKUMA LB-15 TURNING CENTER AND A COMPUTER LAB LOADED WITH THE "SMARTCAM" SOFTWARE PACKAGE. NO TEXTBOOK WAS FOUND TO INCLUDE ALL THREE OF THESE IMPORTANT LAB COMPONENTS; THEREFORE, THE FACTORY SUPPLIED MANUALS WERE USED IN THE DEVELOPMENT AND PRESENTATION OF THE TOPICS COVERED IN THIS COURSE.*

Lecture Topics	Contact Hrs.
Advanced Programming Techniques (Lathe)	3
Threading cycles and grooving cycles	
Roughing for turning and facing operations	
Set-up and Operation of the CNC Mill	6
Tooling for CNC mills	
CNC mill set-up	
CNC mill operation	
Set-up and Operation of the CNC Lathe	12
Tooling for CNC lathes	
CNC lathe set-up	
CNC lathe operation	
Boring soft jaws for the CNC lathe	
SMARTCAM CNC Programming System	14
The Structure of a CAM System	
Process Planning (Mill)	
Working with a CNC Process Model (Mill)	
Generating CNC Code with a CAM System	
Additional Modeling Practices (Mill)	
Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to FADAL CNC Mill Controls and MDI Functions	3
FADAL Setup and Operations	33
Uploading/Downloading via CIMNET Networking System	2
Introduction to OKUMA Controls and MDI Functions	3

Introduction to IGF Programming	6
OKUMA Setup and Operations	27
SMARTCAM CNC Programming	36
Total Lab Hours	**108**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. **PRACTICE SAFETY**
1. Follow Safe Operating Procedures for CNC Machine Tools
   - a. Identify and understand safe CNC machine operating procedures
   - b. Demonstrate safe CNC machine operation

B. **APPLY MATHEMATICAL CONCEPTS**
1. Calculate Speeds and Feeds for Machining
   - a. Calculate RPM for various metals and various tools
   - b. Calculate feed for various metals, tools, and depths of cut
2. Locate Machining Points from a Datum Point
   - a. Identify points using the Cartesian coordinate system
   - b. Identify points using the polar coordinate system
   - c. Identify points using the absolute dimensioning system
   - d. Identify points using the incremental dimensioning system

C. **PERFORM ADVANCED MACHINING PROCESSES**
1. Select and Use CNC Tooling Systems
   - a. Understand machinability and chip formation
   - b. Select proper insert materials and geometry
   - c. Assemble tooling components
   - d. Select correct tooling systems
   - e. Identify tooling cost factors
2. Program CNC Machines
   - a. Identify CNC applications
   - b. List various types of CNC machines
   - c. Discuss CNC machine control systems
   - d. Describe absolute and incremental coordinate systems
   - e. Plan and write programs for CNC mills
   - f. Plan and write programs for CNC lathes
   - g. Edit CNC programs
3. Operate CNC Machining Centers (Mills)
   - a. Install and align work holding devices
   - b. Load/align materials into the machine
   - c. Load tools into machine
   - d. Establish tool length offset for each tool
   - e. Establish/set machine reference
   - f. Load programs into CNC mill
   - g. Demonstrate working knowledge of all controls on the MCU
   - h. Demonstrate proper operation of CNC machining center to include "dry run" and final production

   i. Edit CNC programs for optimum part production
   j. Operate machine in DNC mode if that capability exists

4. Operate CNC Turning Centers (Lathes)
   a. Install and bore soft jaws as required
   b. Load tools into machine
   c. Establish machine reference
   d. Set initial tool offsets
   e. Monitor/adjust offsets for accurate part production
   f. Load programs into CNC lathe
   g. Demonstrate working knowledge of all controls on the MCU
   h. Demonstrate proper operation of CNC lathe to include "dry run" and final production
   i. Edit CNC programs for optimum part production
5. Generate CNC Programs Using a CAM system
   a. Create a Job Plan
   b. Describe the part
   c. Edit the part
   d. Verify tool path
   e. Generate the CNC code
   f. Verify/edit the code
   g. Download the code into the machine via network

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

   A. Resources: *Identifies, organizes, plans, and allocates resources*
      1. follows a schedule to complete assigned tasks on time
      2. follows a schedule to maximize laboratory resources
   B. Interpersonal: *Works with others*
      1. complete assigned responsibilities within the CNC lab serving as a member of the team
      2. provide individual assistance/direction to peers as requested
   C. Information: *Acquires and uses information*
      1. read and interpret blueprints
      2. read and interpret CNC machine tool manuals

3. read and write CNC machine code

D. ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
    - a. organization of personnel and facilities in the CNC lab
    - b. systematic approach to the metal removal process using CNC
    - c. dimensioning and measurement systems
    - d. relationships among the machine tool, its control system, and the program
2. monitors and corrects performance during
    - a. the CNC machining process
    - b. adjustments of individual laboratory work schedule
    - c. constantly evaluating the quality of work to achieve acceptable standards

E. ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to program and produce a part using CNC
2. applies appropriate procedures and uses appropriate tools and equipment to program and produce a machined part using CNC to acceptable standards

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
- a. read/studies CNC machine operating and programming manuals
- b. interprets blueprints and technical drawings
- c. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
- a. outline the steps necessary to program and produce a machine part using CNC
- b. maintain a lecture notebook
- c. write CNC programs for CNC mills and CNC lathes

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
- a. determines optimum machining speeds, feeds, and depth of cut
- b. interconverts fractions to decimal expressions
- c. keeps a running computation of individual grade
- d. identify machining points using the Cartesian coordinate system

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
- a. assimilate classroom instruction
- b. interpret and assimilate video instruction

        c. observe and assimilate laboratory demonstrations
        d. seek and receive individualized instruction in the laboratory
        e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
    5. ***Speaking:** Organizes ideas and communicates orally*
        a. participates in classroom discussions
        b. organize ideas and communicate specific questions to the instructor
        c. verbally affirms understanding of a concept, procedure, or required skill
        d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the CNC lab

B. ***Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
    1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. identifies requirements and uses knowledge and judgement to select a best CNC machining approach from among available alternatives
        b. applies knowledge of processes and requirements to confirm that the process is functioning properly, or to improve the process
    2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
        a. makes daily accommodations to stay on schedule
        b. seeks additional instruction/clarification for assignment completion
        c. troubleshoots and debugs CNC programs
        d. troubleshoots CNC machining systems and takes appropriate actions
    3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
        a. visualize objects in three dimensions from engineering drawings
        b. visualize process during instructor lecture
        c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations
        d. visualize cutter path and position of clamps and workholding devices while preparing CNC programs
    4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. understand that practice will improve skill
        b. asks questions or seeks help when uncertain about new skills or knowledge
    5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. applies knowledge of machining processes, tooling, and materials to optimize CNC machining
        b. applies knowledge of programming system to develop CNC programs in a logical, efficient manner

    c. applies knowledge of workpiece machinability, cutter characteristics and machine tool characteristics to adjust speeds and feeds

C. *Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    - a. displays promptness and preparation for the day's work
    - b. plans work to use time efficiently
    - c. accepts responsibility for mistakes, and takes corrective and preventive actions
    - d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    - a. takes pride in work through positive reinforcement
    - b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. assist classmates in improving technical skills
    - b. share laboratory resources (machines, tools, computers and instructor's individual attention)
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. perform in-process quality checks on machined parts
    - b. maintain a record of academic achievement (individual grade book)
    - c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. ***Integrity/Honesty:** Chooses ethical courses of action*
    - a. accept the responsibility for own actions
    - b. exhibit personal honesty at all times
    - c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
    - d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers
3. Computer Numerical Control by Warren S. Seams, Delmar Publishers

APPENDIX A - INDUSTRY COMPETENCY PROFILES

The following pages contain the individual Competency Profiles for each of the companies surveyed by the MAST development center for the occupational specialty area of . These Competency Profiles/skill standards were used to develop the curriculum for the pilot program.

The participation of the companies as partners in the MAST effort is greatly appreciated. Each company has approved the use of its logo in MAST materials. None of the participating companies shall be held responsible or liable for any of the findings of the project.

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

ALCOA REPRESENTATIVES

MICHAEL L. VIDRINE, P.E.
Central Engineering & Maintenance Service Superintendent

RON KOSTROUN
Machinist

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators) magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

ALCOA

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MACHINIST .... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to accepted engineering standards.

	Duties	Tasks												
A	Interpret Engineering Drawings and Control Documents	A-1 Review blueprint notes and dimensions	A-2 Identify basic layouts of drawings	A-3 Identify basic types of drawings	A-4 List the purpose of each type of drawing	A-5 Draw a print/sketch	A-6 Verify drawing elements	A-7 Use Machinery Handbook	A-8 Identify lines and symbols (GD&T)	A-9 Understand the relationship of engineering drawings to planning	A-10 Use standards to verify requirements	A-11 Analyze bill of materials		
B	Understand Manufacturing Materials and Processes	B-1 Test metal samples	B-2 Discuss hot working processes	B-3 Discuss cold working processes										
C	Demonstrate Measurement/ Inspection Techniques	C-1 Identify types of measurements	C-2 Practice proper measuring skills	C-3 Select proper measurement tools	C-4 Use metric and English standards of measurement	C-5 Perform measurements with hand held instruments	C-6 Perform measurements on surface plate	C-7 Understand SPC						
D	Perform Conventional Machining Operations	D-1 Prepare and plan for machining operations	D-2 Use proper hand tools	D-3 Operate power saws	D-4 Operate drill presses	D-5 Operate vertical milling machines	D-6 Operate horizontal milling machines	D-7 Operate metal cutting lathes	D-8 Operate grinding machines	D-9 Operate deburring equipment	D-10 Describe the different types of gears	D-11 Understand gear terms and calculations	D-12 Use rotary tables and dividing heads	
E	Perform Advanced Machining Operations	E-1 Program CNC machine	E-2 Operate CNC machining centers and turning centers	E-3 Download programs via network										
F	Understand and Use Tooling Systems	F-1 Select proper insert materials/ geometry	F-2 Assemble tooling components	F-3 Select correct tooling systems	F-4 Understand tooling costs/economics									
G	Understand Welding Operations	G-1 Understand SMAW process	G-2 Understand oxyacetylene	G-3 Understand GTAW (heliarc)	G-4 Understand GMAW (mig)/ FCAW	G-5 Metalize shafts								

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

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ROSE MARY TIMMONS
Senior Secretary/Statistician

Facilitated By:

DARRELL DUNGAN
Coordinator
Economic Development and
Industrial Training Division

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

Bell Helicopter
TEXTRON

MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

	Duties	Tasks												
A	**Interpret Engineering Drawings and Control Documents**	A-1 Review blueprint notes and dimensions	A-2 Identify basic layout of drawings	A-3 Identify basic types of drawings	A-4 List the purpose of each type of drawing	A-5 Verify drawing elements	A-6 Identify lines and symbols (GD&T)	A-7 Understand the relationship of engineering drawings to planning	A-8 Use standards to verify requirements	A-9 Analyze bill of materials				
B	**Understand Manufacturing Materials and Processes**	B-1 Select materials with desired properties	B-2 Identify materials and processes to produce a product	B-3 Identify heat treating processes	B-4 Thermal process workpieces	B-5 Test metal samples	B-6 Discuss casting processes	B-7 Discuss hot working processes	B-8 Discuss cold working processes	B-9 Evaluate alternative manufacturing processes				
C	**Demonstrate Measurement/ Inspection Techniques**	C-1 Identify types of measurements	C-2 Practice proper measuring skills	C-3 Select proper measurement tools	C-4 Use Metric and English standards of measurement	C-5 Perform measurements with hand held instruments	C-6 Perform measurements on surface plate	C-7 Perform inspections using stationary equipment						
D	**Perform Conventional Machining Operations**	D-1 Prepare and plan for machining operations	D-2 Use proper hand tools	D-3 Operate power saws	D-4 Operate drill presses	D-5 Operate vertical milling machines	D-6 Operate horizontal milling machines	D-7 Operate metal cutting lathes	D-8 Operate grinding machines	D-9 Operate jig boring machines	D-10 Operate deburring equipment			
E	**Perform Advanced Machining Operations**	E-1 Program CNC machine	E-2 Operate CNC machining centers and turning centers	E-3 Operate electrical discharge machines	E-4 Operate CNC grinders	E-5 Operate CNC jig boring machines	E-6 Download programs via network							
F	**Perform Gear Generating Operations**	F-1 Describe the different types of gears	F-2 Understand gear terms and calculations	F-3 Calculate for direct, simple, and angular indexing	F-4 Use rotary tables and dividing heads	F-5 Make calculations for gear cutting	F-6 Discuss gear inspection	F-7 Operate gear shaping machines	F-8 Operate gear hobbing machines	F-9 Operate gear finishing machines				
G	**Perform Welding Operations**	G-1 Weld with SMAW process	G-2 Weld/cut with oxyacetylene	G-3 Weld with GTAW (Heliarc)	G-4 Weld with GMAW (Mig) / FCAW	G-5 Perform plasma arc cutting (PAC)								

Bell Helicopter TEXTRON
DACUM Panel Members

LUCIEN ROUZE
Department of Employee Training and Development

DAVE PEARL
Administrator of Human Resource Development

MILTON R. SIEMS
Senior Consultant of Human Resource Development

ROBERT D. SWANSON
Administrator of Human Resource Development

JOHN P. DAVIS
International Training Program Manager

ROB EDDIS
Manufacturing Engineering Supervisor/Expert Machinist

BELLMACH.PM3
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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH K. ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

MICHAEL CANADA
Assistant Director of Manufacturing

RICHARD M. WONG
Sr. Manufacturing Engineer

LEO ALANIZ
Machinist

EDDIE GAGE
Machinist

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Electrician's Tools (lineman pliers, wire strippers, screwdrivers, etc.)
Electric Drills and Saws
Conduit Threading Equipment
Measuring Tools
Volt-Ohm-Meters
Tachometers
Amp Meters (Clamp On)
Power Supplies
Oscilloscopes
Signal Generators
Power Distribution Center
Computers
Basic Drafting Tools
Electrical Lighting Equipment
Electrical Switches
Electro-Mechanical Devices (Control Relays, Timers, Contactors, Motor Starters, etc.)
Manual and Hydraulic Conduit Benders
Electrical Panelboards
Hazardous Location Equipment
Wire Pulling Equipment
AC Motors
DC Motors
Servo Motors
Alternators and Generators
Motor/Generator Logic Controllers
Transits
Transformers
Transformer Test Sets
Motor Control Center
Motor Control Troubleshooting Trainers
Switchgear
Protective Metering and Relaying Test Equipment
AC Drives
DC Drives
Servo Drives

FUTURE TRENDS AND CONCERNS

Advanced Computer Applications
Fiber Optic Controls
Advanced Test Equipment
Robotics
Advanced Metering Control

COMPETENCY PROFILE

Machinist

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

BOWEN ®

MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

	Duties	Tasks												
A	Practice Safety	A-1 Assume responsibility for safety	A-2 Follow safety manuals, and all safety regulations/ requirements	A-3 Use protective equipment	A-4 Follow safe operating procedures for hand and machine tools	A-5 Maintain a clean and safe work environment								
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Perform basic trigonometric functions	B-4 Calculate speeds and feeds for machining	B-5 Locate machining points from a datum point	B-6 Perform calculations necessary for turning tapers							
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Describe the relationship of engineering drawings to planning	C-7 Use standards to verify requirements	C-8 Analyze bill of materials (BOM)					
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Describe casting process	D-4 Describe forging process	D-5 Describe color coding systems for metals								
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments								
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate drill presses	F-4 Operate vertical milling machines	F-5 Operate horizontal milling machines	F-6 Operate metal cutting lathes	F-7 Operate grinding/abrasive machines	F-8 Operate deburring equipment	F-9 Operate vertical turning machine (Bullard)	F-10 Operate horizontal boring mill	F-11 Operate hydraulic presses	F-12 Operate broaching machines and shapers	F-13 Operate power honing machines
		F-14 Operate trepanning machine	F-15 Operate back bore machine	F-16 Perform freehand cutter grinding										
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Operate CNC machining centers (mills)	G-4 Operate CNC turning centers (lathes)									
H	Perform Gear Generating Operations	H-1 Describe the different types of gears	H-2 Understand gear terms	H-3 Use rotary tables and dividing heads	H-4 Discuss gear inspection and measurement	H-5 Machine a spur gear								

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

GREG LASKY
Machinist

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Training to Operate New Advanced Equipment
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

CHRYSLER
MOUND ENGINE

BEST COPY AVAILABLE

MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

	Duties	Tasks												
A	Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Solve for little "h"			
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 Understand and use quality systems			
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Perform heat treating operations	D-4 Test metal samples for hardness	D-5 Identify types of plastic materials and processes								
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments	E-6 Perform measurements on surface plate	E-7 Perform inspections using stationary equipment						
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment			
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Operate electrical discharge machines							
H	Perform Gear Cutting Operations	H-1 Describe the different types of gears	H-2 Understand gear terms	H-3 Use rotary tables and dividing heads	H-4 Discuss gear inspection and measurement	H-5 Machine a spur gear								
I	Perform Welding Operations	I-1 Weld with Shielded Metal Arc Welding (SMAW) process	I-2 Weld/cut with oxyacetylene	I-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	I-4 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)									

SKILLS AND KNOWLEDGE
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

JERRY CRAWFORD
Division Manager

RICHARD GRIFFIN
Manufacturing Manager

KAYLE ROWLEE
Machine/Fabrication Shop Supervisor

Texas State
Technical College
Waco

TRAITS AND ATTITUDES
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT
Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS
Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

CHRYSLER
TECHNOLOGIES
AIRBORNE SYSTEMS, INC.

MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

Duties ← **Tasks** →

A	Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements (Haz. Com. Act)	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Solve for little "h"			
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)				
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Perform heat treating operations	D-4 Test metal samples for hardness	D-5 Identify types of plastic materials and processes								
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments	E-6 Perform measurements on surface plate	E-7 Perform inspections using stationary equipment						
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate tool and cutter grinders	F-10 Operate deburring equipment	F-11 Perform preventative maintenance		
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Perform preventative maintenance							
H	Use Computers	H-1 Use computer operating systems	H-2 Use computer inquiry systems	H-3 Use various computer applications	H-4 Use bar coding	H-5 Use CAD/CAM system								
I	Participate in Total Quality and SPC Activities	I-1 Define quality in manufacturing and explain importance	I-2 Perform Statistical Process Control (SPC) functions	I-3 Analyze machining problems and recommend solutions										

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE FENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

LARRY WRIGHT, Supervisor
ROBERT LINDSAY, Machinist
JOHN HAMMOND, Machinist

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Composites
Laser Machining
Advanced Computer Applications
Robotic Control of Machines
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
More Variety of Machines
(Vertical and Horizontal Mills)

COMPETENCY PROFILE

Machinist

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

DARR
EQUIPMENT CO.
CAT

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MACHINIST.... **plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.**

Duties		Tasks												
A	Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/ English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations necessary for turning tapers						
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Describe the relationship of engineering drawings to planning	C-7 Use standards to verify requirements	C-8 Analyze bill of materials (BOM)					
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Test metal samples for hardness	D-4 Identify cast iron/cast steel forgings	D-5 Design and fabricate hand tooling								
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments								
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate metal cutting lathes	F-6 Operate grinding/ abrasive machines	F-7 Operate jig boring machines	F-8 Operate deburring equipment	F-9 Operate vertical turning machine (Bullard)	F-10 Operate horizontal boring mill	F-11 Operate hydraulic presses		
G	Perform Welding Operations	G-1 Weld with Shielded Metal Arc Welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Hard surface metal with spray transfer (metalizing)										

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Improvement Activities
Practice Quality-Consciousness in Performance of the Job

CENTRAL FLORIDA COMMUNITY COLLEGE PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Dean/Technical Education

MIKE FOX
Director/Industry Services

LARRY MYFORD
Coordinator/Manufacturing Technology

KEN DEWHURST
Instructor/Industrial Machinery Maintenance & Repair

EMERGENCY ONE, INC. MANAGEMENT TEAM AND EXPERT WORKERS

DAN WOMBOLD, Vice President Human Resources
JIM WHITE, Vice President/Manufacturing
C. SHIMEALL, Plant Manager, Chassis
BILL RHODES, Production Manager/Body Plant
RON STEPHENS, Human Resources Manager
ELAINE SWIGART, Human Resources Supervisor
DONNA TACKETT, Health & Safety Supervisor
JEFF O'STEEN, Supervisor

E-ONE

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Awareness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Screwdrivers, Wrenches, etc.
Electric Drills and Saws
Measuring Tools
Caulking Guns
Basic Drafting Tools
Electrical Lighting Equipment
General Tools (Hacksaws, Sheet Metal Snips,
    Diagonal Cutting Pliers, Etc.)
Cut-off Saws
Hand Grinders
Hand Tapping Holes
Hand Reamers
Files
Machines Tools (manual and CNC): lathes, milling machines,
    drill press, punch press, shears, brake
Impact and Torque Wrenches
Arbor/Shop Presses

FUTURE TRENDS AND CONCERNS

Reamers
Socket Drives
Pop Rivets

COMPETENCY PROFILE

Fabrication Operator

Prepared by
Central Florida Community College

and
Emergency One, Inc.

E-ONE

December 1995

E-ONE

FABRICATION OPERATOR...uses mechanical skills to manufacture assemblies and sub-assemblies of the chassis and bodywork

	Duties	Tasks												
A	Practice Safety	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Support all practices and use of protective equipment	A-4 Demonstrate an understanding of proper hazardous material handling	A-5 Know first aid and CPR	A-6 Follow safety manuals and all safety regulations/ requirements	A-7 Use protective equipment	A-8 Follow safe operating procedures for hand and machine tools	A-9 Maintain a clean and safe work environment				
B	Practice Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing processes	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Demonstrate Communication Skills	D-1 Be an active listener	D-2 Demonstrate good reading, comprehension, and writing skills	D-3 Demonstrate ability to prepare recommendations for continuous improvement	D-4 Summarize and prioritize work responsibilities	D-5 Express ideas clearly	D-6 Demonstrate ability to give and follow instructions	D-7 Accept constructive criticism	D-8 Demonstrate ability to communicate with co-workers and management					
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved in problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand the purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Interconvert Metric/ English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purposes of analysis and problem-solving							
G	Interpret Engineering Drawings and Control Documents	G-1 Review blueprint notes and dimensions	G-2 Identify basic layout of drawings	G-3 Identify basic types of drawings	G-4 List the purpose of each type of drawing	G-5 Verify drawing elements	G-6 Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology	G-7 Read/ Interpret prints from different Trades/Occupations						
H	Use Precision Measuring Tools	H-1 Identify types of measurement	H-2 Select proper measurement tools	H-3 Apply proper measuring techniques	H-4 Use Metric and English Standards of measurement	H-5 Perform measurements with hand held instruments	H-6 Verify that tool calibration falls within calibration schedule							
I	Use Proper Hand Tools	I-1 Use arbor and shop presses	I-2 Select necessary work-holding devices and hand tools as needed	I-3 Select and use hand files	I-4 Identify and use hand reamers	I-6 Follow tapping procedures to produce internal threads	I-7 Use thread-cutting dies to produce external threads	I-8 Operate bench and pedestal grinders safely	I-9 Install helicoils	I-10 Use impact wrenches	I-11 Use torque wrenches	I-12 Use gasket cutters	I-13 Identify & use correct corrosion control procedures and materials	
J	Set-up and Operate Machine Tools	J-1 Lathe Operations	J-2 Milling Machine Operations	J-3 Drill Press	J-4 Punch Press, Shears & Brakes	J-5 Routine/ Daily Maintenance Activities								

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FABRICATION OPERATOR...continued

Duties ← **Tasks** →

K Emergency Vehicle Terminology	K-1 Display a general understanding of emergency vehicle terminology	K-2 Understand the functions of equipoement being assembled	K-3 Understand how components relate as a total system										
L Wellness/ Physical Abilities	L-1 Demonstrate ability to lift 50 pounds	L-2 Demonstrate ability to tolerate heights up to 100 feet	L-3 Ability to work from various positions while standing on concrete for extended periods	L-4 Display ability to work in hot/cold environment for 8-10 hours	L-5 Present a history of documented regular attendance at work	L-6 Apply wellness information to lifestyle to maintain health							

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Improvement Activities
Practice Quality-Consciousness in Performance of the Job

CENTRAL FLORIDA COMMUNITY COLLEGE PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Dean/Technical Education

MIKE FOX
Director/Industry Services

LARRY MYFORD
Coordinator/Manufacturing Technology

KEN DEWHURST
Instructor/Industrial Machinery Maintenance & Repair

EMERGENCY ONE, INC. MANAGEMENT TEAM AND EXPERT WORKERS

DAN WOMBOLD, Vice President Human Resources
JIM WHITE, Vice President/Manufacturing
ROD NIEMANN, Plant Manager/Body Plant
RON STEPHENS, Human Resources Manager
ELAINE SWIGART, Human Resources Supervisor
DONNA TACKETT, Health & Safety Supervisor
A. SMITH, Plant Manager/Aerial Plant
R. L'HEUREUX, Supervisor

E-ONE

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Awareness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machine Tools (manual & CNC):
- Lathes
- Milling Machines
- Drill Press
- Surface Grinder
- Cut-off Saw
- Grinders
- Tapping Head
- Boring Head

Hand Tools:
- Hacksaws
- Hand Tapping
- Files
- Grinders
- Arbor Press (Hydraulic or manual)

FUTURE TRENDS AND CONCERNS

CNC Machines - Setup and Operation
Multi-axis programming/machining

COMPETENCY PROFILE

Machinist

Prepared by
Central Florida Community College

and
Emergency One, Inc.

E-ONE®

December 1995

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MACHINIST...plan, layout, setup, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

Duties		← Tasks →												
A	Practice Safety	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Support all practices and use of protective equipment	A-4 Demonstrate an understanding of proper hazardous material handling	A-5 Know first aid and CPR	A-6 Follow safety manuals and all safety regulations and requirements	A-7 Use protective equipment	A-8 Follow safe operating procedures for hand and machine tools	A-9 Maintain a clean and safe work environment				
B	Practice Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommended improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Demonstrate Communication Skills	D-1 Be an active listener	D-2 Demonstrate good reading, comprehension, and writing skills	D-3 Summarize and prioritize work responsibilities	D-4 Express ideas clearly	D-5 Demonstrate ability to give and follow instructions	D-6 Accept constructive criticism							
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Apply Mathematical Concepts	F-1 Perform basic arithmetic functions	F-2 Interconvert fractions/ decimals	F-3 Interconvert Metric/ English measurements	F-4 Perform basic trigonometric functions	F-5 Calculate speeds and feeds for machining	F-6 Locate machining points from a datum point	F-7 Perform calculations for sine bar and sine plate	F-8 Calculate for direct, simple and angular indexing	F-9 Perform calculations necessary for turning tapers	F-10 Solve for little "H" calculating for depth of cut			
G	Engineering Drawings and Control Documents	G-1 Review blueprint notes and dimensions	G-2 Identify basic layout of drawings	G-3 Identify basic types of drawings	G-4 List the purpose of each type of drawing	G-5 Verify drawing elements, check for revisions & out-of-date blueprints	G-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	G-7 Analyze Bill of Materials (BOM)	G-8 Read/interpret prints from different trades/ occupations					
H	Perform Measurement/ Inspection	H-1 Identify types of measurement	H-2 Select proper measurement tools	H-3 Apply proper measuring techniques	H-4 Use Metric and English standards of measurement	H-5 Perform measurements with hand held instruments	H-6 Perform measurements on surface plate	H-7 Align workpieces using height gage and dial indicators						
I	Perform Conventional Machining Operations	I-1 Prepare and plan for machining operations	I-2 Use proper hand tools	I-3 Operate power saws	I-4 Operate drill presses	I-5 Operate vertical milling machines	I-6 Operate horizontal milling machines	I-7 Operate metal cutting lathes	I-8 Operate grinding/ abrasive machines	I-9 Operate deburring equipment				
J	Perform Advanced Machining Processes	J-1 Prepare and plan for CNC machining operations	J-2 Select and use CNC tooling systems	J-3 Operate CNC Machining centers (mills)										

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E-ONE

MACHINIST...continued

Duties		Tasks											
M	Emergency Vehicle Terminology	M-1 Display a general understanding of emergency vehicle terminology	M-2 Understand the functions of equipment being assembled	M-3 Understand how components relate as a total system									
N	Wellness/ Physical Abilities	N-1 Demonstrate ability to lift 50 pounds	N-2 Demonstrate ability to tolerate heights up to 100 feet	N-3 Ability to work from various positions while standing on concrete for extended periods	N-4 Display ability to work in hot/cold environment for 8-10 hours	N-5 Present a history of documented regular attendance at work	N-6 Apply wellness information to lifestyle to maintain health						

SKILLS AND KNOWLEDGE
Direct vs. Indirect Cost Understanding
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Conscientiousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

RICKY FLAK
Vice President - Operations

NICK NICHOLS
Manufacturing Manager - Diamond Products

BOBBY IRWIN
Machinist

Texas State Technical College Waco

TRAITS AND ATTITUDES
Cost Conscientiousness
Empowerment of Employees
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT
Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS
Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

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COMPETENCY PROFILE

Machinist

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

Texas State Technical College Waco

SMITH SII GEODIAMOND

MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Perform basic trigonometric functions	B-4 Calculate speeds and feeds for machining	B-5 Locate machining points from a datum point	B-6 Perform calculations for sine bar and sine plate	B-7 Calculate for direct, simple, and angular indexing	B-8 Perform calculations necessary for turning tapers	B-9 Solve for little "h"				
C Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)				
D Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Perform heat treating operations	D-4 Test metal samples for hardness									
E Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use English standards of measurement	E-5 Perform measurements with hand held instruments	E-6 Perform measurements on surface plate	E-7 Perform inspections using stationary equipment						
F Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Use rotary tables and dividing heads	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate deburring equipment				
G Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Operate electrical discharge machines							
H Perform Welding Operations	H-1 Weld with Shielded Metal Arc Welding (SMAW) process	H-2 Weld/cut with oxyacetylene	H-3 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)										

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

Facilitated By:

DR. JON BOTSFORD
Assistant Director
Machine Tool Advanced Skills
Technology Program (MAST)

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators) magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

MERCURY TOOL
&
MACHINE, INC.
WACO, TEXAS

MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to accepted engineering standards.

Duties		Tasks												
A	Interpret Engineering Drawings and Control Documents	A-1 Review blueprint notes and dimensions	A-2 Identify basic layouts of drawings	A-3 Identify basic types of drawings	A-4 List the purpose of each type of drawing	A-5 Draw a print/sketch	A-6 Verify drawing elements	A-7 Use Machinery Handbook	A-8 Identify lines and symbols (GD&T)	A-9 Understand the relationship of engineering drawings to planning	A-10 Use standards to verify requirements	A-11 Analyze bill of materials		
B	Understand Manufacturing Materials and Processes	B-1 Select material with desired properties	B-2 Identify materials and processes to produce a product	B-3 Identify heat treating processes	B-4 Thermal process workpieces	B-5 Test metal samples	B-6 Discuss casting processes	B-7 Discuss hot working processes	B-8 Discuss cold working processes	B-9 Evaluate alternative manufacturing processes				
C	Demonstrate Measurement/ Inspection Techniques	C-1 Identify types of measurements	C-2 Practice proper measuring skills	C-3 Select proper measurement tools	C-4 Use metric and English standards of measurement	C-5 Perform measurements with hand held instruments	C-6 Perform measurements on surface plate	C-7 Perform inspections using stationary equipment	C-8 Understand SPC					
D	Perform Conventional Machining Operations	D-1 Prepare and plan for machining operations	D-2 Use proper hand tools	D-3 Operate power saws	D-4 Operate drill presses	D-5 Operate vertical milling machines	D-6 Operate horizontal milling machines	D-7 Operate metal cutting lathes	D-8 Operate grinding machines	D-9 Operate deburring equipment				
E	Perform Advanced Machining Operations	E-1 Program CNC machine	E-2 Operate CNC machining centers and turning centers	E-3 Operate electrical discharge machines	E-4 Download programs via network									
F	Understand and Use Tooling Systems	F-1 Select proper insert materials/ geometry	F-2 Assemble tooling components	F-3 Select correct tooling systems	F-4 Understand tooling costs/economics									
G	Perform Welding Operations	G-1 Weld with SMAW process	G-2 Weld/cut with oxyacetylene	G-3 Weld with GTAW (heliarc)	G-4 Weld with GMAW (mig)/ FCAW	G-5 Perform plasma arc cutting (PAC)								

MERCURY TOOL & MACHINE, INC

Panel Members

JACK PECK, SR.
President

JACK PECK, JR.
Vice President

H. TOM KAYLOR
Plant Manager

MSSMACH.PM5
MAST [illegible]

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH K. ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

MARTY SCHMIDT
Senior Manufacturing Engineer
and Systems Design Engineer

MICHAEL KON
Manufacturing Engineer and
CNC Systems/Program Engineer

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE

Machinist

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

LOCKHEED MARTIN

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MACHINIST.... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

	Duties	← Tasks →												
A	Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Solve for little "k"			
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)				
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Perform heat treating operations	D-4 Test metal samples for hardness									
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments	E-6 Perform measurements on surface plate	E-7 Perform inspections using stationary equipment						
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Set up/ operate power saws	F-4 Set up/ operate drill presses	F-5 Set up/ operate vertical milling machines	F-6 Set up/ operate horizontal milling machines	F-7 Set up/ operate metal cutting lathes	F-8 Set up/ operate grinding/ abrasive machines	F-9 Set up/ operate jig boring machines	F-10 Set up/ operate deburring equipment			
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Set up/ operate CNC machining centers (mills)	G-5 Set up/ operate CNC turning centers (lathes)	G-6 Set up/ operate electrical discharge machines							
H	Perform Gear Generating Operations	H-1 Describe the different types of gears	H-2 Understand gear terms	H-3 Use rotary tables and dividing heads	H-4 Discuss gear inspection and measurement	H-5 Machine a spur gear								
I	Perform Welding Operations	I-1 Weld with Shielded Metal Arc Welding (SMAW) process	I-2 Weld/cut with oxyacetylene	I-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	I-4 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)									

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

REED TOOL COMPANY REPRESENTATIVE

EDWARD MACIK
Master Machinist/Leadman

Texas State
Technical College
Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

REED
TOOL COMPANY
A SUBSIDIARY OF CAMCO

MACHINIST .... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

Duties ← **Tasks** →

A	Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Solve for little "h"			
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)				
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Perform heat treating operations	D-4 Test metal samples for hardness									
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Proper care of precision and semi-precision measuring tools	E-4 Apply proper measuring techniques	E-5 Use Metric and English standards of measurement	E-6 Perform measurements with hand held instruments	E-7 Perform measurements on surface plate	E-8 Perform inspections using stationary equipment					
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/ abrasive/lapping machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment	F-11 Use rotary tables and dividing heads		
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Operate electrical discharge machines							
H	Perform Welding Operations	H-1 Weld with Shielded Metal Arc Welding (SMAW) process	H-2 Weld/cut with oxyacetylene	H-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	H-4 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)									

[illegible]

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Texas State
Technical College
Waco

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
Multi-axis Turning
Or Machine Probing
Adaptive Controls
Advanced Materials and Processes
3-D Solid Concepts

Furnished by:

RONALD E. STOLTZ, Ph.D.
Manager, Manufacturing Programs

JERRY FISCHER
Machine Shop Supervisor

JOHN FORDHAM
Machinist

COMPETENCY PROFILE

Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

Sandia National Laboratories

MACHINIST.... **plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.**

	Duties	Tasks												
A	**Practice Safety**	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	**Apply Mathematical Concepts**	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Solve for little "h"			
C	**Interpret Engineering Drawings and Control Documents**	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 Understand and use quality systems			
D	**Recognize Different Manufacturing Materials and Processes**	D-1 Identify materials with desired properties	D-2 Describe the heat treating process	D-3 Perform heat treating operations	D-4 Test metal samples for hardness	D-5 Identify types of plastic materials and processes	D-6 Identify advanced manufacturing processes	D-7 Identify process variables (dirt, corrosion, vibration, etc)						
E	**Perform Measurement/ Inspection**	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments	E-6 Perform measurements on surface plate	E-7 Perform inspections using stationary equipment						
F	**Perform Conventional Machining Operations**	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment	F-11 Identify tooling capabilities	F-12 Apply tool and die design and build principles	
G	**Perform Advanced Machining Processes**	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Upload/ download files via network	G-7 Operate CAM system	G-8 Perform basic CAD functions	G-9 Operate Computers				
H	**Perform Gear Cutting Operations**	H-1 Describe the different types of gears	H-2 Understand gear terms	H-3 Use rotary tables and dividing heads	H-4 Discuss gear inspection and measurement	H-5 Machine a spur gear								
I	**Perform Welding Operations**	I-1 Weld with Shielded Metal Arc Welding (SMAW) process	I-2 Weld/cut with oxyacetylene	I-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	I-4 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)									

SKILLS AND KNOWLEDGE
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job
Environmental Concerns

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished by:

THE UNITED STATES ARMY TANK-AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTERS (TARDEC)

RALPH RUMPZ
Tool Maker Supervisor

SANTIAGO PONTI
Mechanical Engineer Team Leader

ROBERT M. PETROVICH
Machinist

TIM O'CONNELL
Machinist

Texas State
Technical College
Waco

TRAITS AND ATTITUDES
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT
Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS
Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
Virtual Manufacturing Processing
Modular Fixturing

COMPETENCY PROFILE
Machinist

Conducted By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State
Technical College
Waco

TARDEC

BEST COPY AVAILABLE

MACHINIST .... plan, layout, set up, and operate hand and machine tools to perform machining operations necessary to produce a workpiece to referenced engineering standards.

	Duties	← Tasks →												
A	Practice Safety	A-1 Follow OSHA safety manuals and all safety regulations/requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/decimals	B-3 Interconvert Metric/English measurements	B-4 Perform basic trigonometric functions	B-5 Calculate speeds and feeds for machining	B-6 Locate machining points from a datum point	B-7 Perform calculations for sine bar and sine plate	B-8 Calculate for direct, simple, and angular indexing	B-9 Perform calculations necessary for turning tapers	B-10 Solve for little "h"	B-11 Use a scientific function calculator		
C	Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 Understand and use quality systems			
D	Recognize Different Manufacturing Materials and Processes	D-1 Identify types of plastic materials and processes	D-2 Identify materials with desired properties	D-3 Describe the heat treating process	D-4 Perform heat treating operations	D-5 Test metal samples for hardness	D-6 Operate sheet metal tools and devices							
E	Perform Measurement/ Inspection	E-1 Identify types of measurements	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Use Metric and English standards of measurement	E-5 Perform measurements with hand held instruments	E-6 Perform measurements on surface plate	E-7 Perform inspections using stationary equipment						
F	Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment			
G	Perform Advanced Machining Processes	G-1 Prepare and plan for CNC machining operations	G-2 Select and use CNC tooling systems	G-3 Program CNC machines	G-4 Operate CNC machining centers (mills)	G-5 Operate CNC turning centers (lathes)	G-6 Operate automatic tracer machining							
H	Perform Gear Cutting Operations	H-1 Describe the different types of gears	H-2 Understand gear terms	H-3 Use rotary tables and dividing heads	H-4 Discuss gear inspection and measurement	H-5 Machine a spur gear								
I	Perform Welding Operations	I-1 Weld with Shielded Metal Arc Welding (SMAW) process	I-2 Weld/cut with oxyacetylene	I-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	I-4 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)	I-5 Use Bowen tool flame cutting pieces								

APPENDIX B - PILOT PROGRAM NARRATIVE

What follows is a narrative of the pilot program which was conducted for this particular occupational specialty.

Machine Tool Advanced Skills
Technology Program (MAST)
3801 Campus Dr. Waco, Texas 76705
817/867-4849 FAX: 817/867-3380
http://machinetool.tstc.edu/

Texas State
Technical College
Waco

MAST STUDENT PILOT PROGRAM
DESCRIPTION/NARRATIVE

The following narrative describes the one year pilot program which was conducted at Texas State Technical College - Waco, during the 1995-96 school year.

- APPLICATION AND SELECTION PROCESS

Recruiting efforts were begun in January 1995. Letters were sent and visits were made to these and other local area high schools. Connally High School, La Vega High School, Waco High School, Marlin High School, Killeen High School, and Midway High School. At each school MAST project staff discussed the MAST program with both faculty, counselors and students. Applications were given out and, when possible, tours to the college were arranged. (Examples of these letters and other correspondence is located at the end of this section.) MAST project staff also made presentations to numerous industries and to regional secondary school conferences in an attempt to recruit students for the MAST program. MAST project staff also arranged "in home" visits with some families when possible. MAST project staff made presentations whenever student tours were arranged on our college campus.

MAST project staff also contracted with the video production arm of TSTC to produce a recruiting video for the Manufacturing Engineering Technology Department. This video has been distributed to a number of local school counselors, faculty and administrators. (A copy of this video has been included as part of the MAST project deliverables.)

Machine Tool Advanced Skills Technology Progra
Texas State Technical College-3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221
MAST

March 27, 1995

Ms. Gray
Vocational Counselor
La Vega High School
555 N. Loop 340
Waco, Texas 76705

Ms. Gray;

I wish to reaffirm my offer to visit the La Vega High School campus, and speak with you, your staff, any interested teachers, and prospective students concerning the special opportunities which are related to the MAST grant at TSTC. I am always grateful for the opportunity to speak about the resources of Texas State Technical College at La Vega since I am a product of the La Vega Independent School District. I also look forward to having you and your students visit our campus, tour our facilities, and explore career opportunities available at Texas State Technical College.

The following will provide you with an overview of the MAST project:

Texas State Technical College has been awarded a $1,472,000 grant by the U.S. Department of Education to develop and implement training curriculum model to overcome skill shortages in the machine tool and metals related industries. This grant project is titled "Machine Tool Advanced Skills Technology" Program or M.A.S.T. The goals of the grant project are:

1. define national skills standards for those persons entering the machine trades areas;
2. develop curriculum materials to support these skill standards;
3. increase awareness and identify career opportunities in the machine tool and metal related industries;
4. develop school-to-work programs with secondary school students and industrial partners;
5. offer out-of-school underemployed and existing industry employees the opportunity to learn new skills and upgrade existing skills;
6. to develop internship/apprenticeship programs with industrial partners as a capstone experience in both certificate and Associate of Applied Science (AAS) programs;
7. conduct a one year "pilot" program with 25 selected students at each college curriculum development center to evaluate curriculum content and effectiveness;
8. identify skill competencies of program applicants at point of entrance and exit;
9. compile and package the program model in multi-media from for national dissemination including course syllabi, textbooks, handbooks, laboratory manuals, recommended equipment, and standardized examinations and evaluative tools.

An important component of the project is to "pilot test" the Machinist Certificate curriculum at Texas State Technical College by enrolling twenty five (25) interested students to evaluate and validate curriculum content and effectiveness. The grant proposal includes funds for student scholarships. This money is available for tuition, fees, and books for students entering the program. Students applying for these scholarships will need to meet our normal entrance requirements as outlined in the current TSTC catalog.

These students would be required to enroll in the one year Machining Option, which is part of the Manufacturing Engineering Technology Department. Student achievement will be followed as they progress through the curriculum, job placement, and in the workplace as a part of the terms of the scholarship.

I ask for your assistance in identifying those students who will be graduating before Fall 1995 or recent graduates (past 2-5 years) who might be interested in participating in this project. There are currently many excellent career opportunities available for young people interested in the manufacturing technologies. TSTC would like to become a partner with you and La Vega High School to identify students interested in participating in this project and preparing people for well paying careers.

I have included a MAST Program Interest Form and respectfully request that you inform potential students of the program, its goals, and available scholarship support. Please return any completed forms in the enclosed postage prepaid envelope and I will send additional information and application for the program to any interested students. If you have any questions please feel free to call me at (817) 867-3526. Thank you for your support in this educational endeavor and I look forward to a successful partnership with La Vega High School and Texas State Technical College.

Sincerely,

Wallace Pelton
Site Coordinator: MAST Program
Texas State Technical College
3801 Campus Dr.
Waco, Texas 76705
(817) 867-3526

encl: student interest form
postage prepaid envelope

Machine Tool Advanced Skills Technology Program
Texas State Technical College-3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221
MAST

MAST Program Interest Form

Please return completed forms to the MAST office at Texas State Technical College. A postage paid return envelope is enclosed for your convenience. Please photocopy as required. I understand that interested students will be mailed information about the MAST program within the next few weeks.

The following students have expressed an interest in participating in the MAST curriculum project for the Fall 1995 entering class in the Machinist Certificate Program.

Name__________ Age____ Home Phone__________

Home Address__________ City/State__________ ZIP______

Graduation Year______ Parent/Guardian__________ Phone________

Name__________ Age____ Home Phone__________

Home Address__________ City/State__________ ZIP______

Graduation Year______ Parent/Guardian__________ Phone________

Name__________ Age____ Home Phone__________

Home Address__________ City/State__________ ZIP______

Graduation Year______ Parent/Guardian__________ Phone________

Name__________ Age____ Home Phone__________

Home Address__________ City/State__________ ZIP______

Graduation Year______ Parent/Guardian__________ Phone________

From:

Teacher/Counselor Name__________

Position: __________

School__________ School Phone Number__________

Machine Tool Advanced Skills Technology Program (MAST)
3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221

Texas State
Technical College
Waco

Dear Interested Student,

Thank you for your interest in the Machine Tool Advanced Skills Technology Program (MAST) at Texas State Technical College.

Texas State Technical College has been awarded a $1,472,000 grant by the U.S. Department of Education to develop and implement a training curriculum model to overcome skill shortages in the machine tool and metals related industries. This grant project is titled "Machine Tool Advanced Skills Technology Program" or M.A.S.T. The goals of the grant project are:

1. to define national skills standards for those persons entering the machine trades areas;
2. develop curriculum materials to support these skill standards;
3. increase awareness and identify career opportunities in the machine tool and metal related industries;
4. develop school-to-work programs with secondary school students and industrial partners;
5. offer out-of-school underemployed and existing industry employees the opportunity to learn new skills and upgrade existing skills;
6. to develop internship/apprenticeship programs with industrial partners as a capstone experience in both certificate and Associate of Applied Science (AAS) programs;
7. conduct a one year "pilot" program with 25 selected students at each college curriculum development center to evaluate curriculum content and effectiveness;
8. identify skill competencies of program applicants at point of entrance and exit;
9. compile and package the program model in multi-media form for national dissemination, including course syllabi, textbooks, handbooks, laboratory manuals, recommended equipment, and standardized examinations and evaluative tools.

An important component of the project is to "pilot test" the Machinist Certificate curriculum at Texas State Technical College by enrolling twenty-five (25) interested students to evaluate and validate curriculum content and effectiveness. Scholarship money is available to pay for tuition, fees, and books for those students accepted into the program. As a student applying for this scholarship you will need to meet our normal entrance requirements as outlined in the current TSTC catalogue. You will be required to enroll in the one year Machining Option, which is part of the Manufacturing Engineering Technology Department. As part of the terms of the scholarship, your achievements will be followed as you progress through the curriculum and into the workplace.

Currently there are many excellent career opportunities available for trained, skilled technicians in the Manufacturing Technologies. The State of Texas is facing a severe shortage of skilled technicians in the machine and manufacturing trades. Additionally, the employment potential for skilled technicians is great. I invite you and your parents to visit the TSTC campus, tour our facilities, learn more about the Machinist curriculum, identify the opportunities available through the MAST program, and the career potential in machining technology. I encourage you to apply for a scholarship and complete the MAST Program Application in Manufacturing Engineering Technology, Machinist Certificate Option. Scholarship Application deadline is July 1, 1995 for Fall 1995 enrollment. Please complete the application as soon as possible and return it to:

Mast Program; ITC 134
Texas State Technical College
3801 Campus Drive
Waco, Texas 76705

If you would like to make an appointment to visit the campus, tour our facilities, and learn more about the curriculum and the MAST program please call me at (817) 867-3526.

Sincerely,

Terry Sawma
Research Coordinator
Texas State Technical College
3801 Campus Dr.
Waco, Texas 76705
(817) 867-3526

Wallace Pelton
Site Coordinator: MAST Program
Texas State Technical College
3801 Campus Dr.
Waco, Texas 76705
(817) 867-3526

MAST student application

wp/ ts revised
MAST 040595
student application/letter

- FUNDING AUGMENTATIONS

As part of the MAST grant, the MAST Project Director offered to fund twenty five (25) scholarships for the school year 1995-96 to assist in recruiting students to pilot test the MAST curriculum. The scholarships would be for a period of 1 year (4 quarters) and would pay for tuition, fees and books for each of the students selected to receive the scholarship. Criteria for scholarship eligibility were determined and a scholarship application form was created and distributed to all interested young people by the MAST staff. (Scholarship-related documentation is found at the end of this section.)

By August 1, 1995 MAST had received 31 scholarship applications. MAST project staff met and selected 25 students to participate in the scholarship program. (A complete listing of these students is found at the end of this section.) These students were notified by letter and by telephone. These students, along with their parents, were invited to our campus on July 14, 1995 for a tour and an information session. (A copy of the student's program booklet is found at the end of this section.) At this time the students were provided information about registration, housing, registration, and information about the MAST program. Students were then introduced to MAST business and industry partners at the MAST Steering Committee meeting which had been scheduled to coincide with the students visit to our campus. The day concluded with a campus tour.

Students were enrolled, tuition and fees paid, and books purchased in time for classes to begin in the Fall 1995.

- APPRENTICESHIP, COOP AND/OR INTERNSHIP PARTICIPATION

No formal apprenticeships, coops or internships have been established at this time although many companies expressed an interest in participating in one of these programs at a later time.

Machine Tool Advanced Skills
Technology Program (MAST)
3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221

Texas State
Technical College
Waco

MAST Program Application
Manufacturing Engineering Technology: Machinist Certificate Option

*Please return completed forms to the **MAST** Office, ITC 134, at Texas State Technical College, Waco.*

Please complete all requested information to apply for a MAST scholarship in Manufacturing Engineering Technology, Machinist Certificate Option. The information will be used in preparing your permanent records. Please complete all information accurately and return by July 1, 1995.

Personal Data:

1. Name-Last ____________ First ____________ MI ____
2. Permanent Address ____________
3. City ____________ 4. County ____________
5. State ____________ 6. Zip Code ____________ 7. Country (If other than USA) ____________
8. Social Security Number ____________
9. Sex: Male ____ Female ____ 10. Birthdate ____________
11. Phone Number ____________

Enrollment Information:

12. Are you a Texas Resident ? Yes ______ No ______
13. High School Attended ____________
14. High School Graduate ____ GED ____ Junior College Graduate ____ College Graduate ____

15. Do you hold a college degree ? Yes ____ No ____

If Yes, Name of College or University ______________________________

Major ______________________ Name of Degree ______________________

Date of Graduation ______________________

Employment Status;

16. Employed: Full-Time ______ Part-Time ______

Unemployed, Seeking work ______ Unemployed, Not Seeking Work ______

17. **In your own handwriting, please explain why you would like to be considered for acceptance into the MAST program's Manufacturing Engineering Technology Machinist Option at Texas State Technical College. Describe your long term goals and expectations.**

Machine Tool Advanced Skills
Technology Program (MAST)
3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221

Texas State
Technical College
Waco

To: MAST Scholarship Recipients
Manufacturing Engineering Technology
Machinist Certificate Option

From: Joe Penick
MAST Project Director

Subject: Conditions of MAST Scholarship

Date: November 6, 1995

Conditions of the MAST Scholarship are as follows:

1. enrollment in all required courses in the machining certificate program for the current quarter semester;

2. successful completion of all required courses in each quarter semester with a cumulative grade point average (GPA) of 2.0.

We would like for you to register for courses each Quarter during Early Registration week. Once you have signed up for your courses at the MET office, please bring your class schedule to the MAST office, 100 Fifth Street. One of the MAST staff will assist you in the completion of the registration process. If you have any questions about the MAST scholarship, course registration, academic advisement, financial aid, campus housing, facilities, etc., please stop by the MAST office and visit with Mr. Pelton, Mr. Sawma, or Ms. Timmons or call (817) 867-3526.

Again, congratulations and I hope you will enjoy your experiences at TSTC.

Machine Tool Advanced Skills
Technology Program (MAST)
3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221

Texas State
Technical College
Waco

October 31, 1995

Mr. Christopher Pitts

Congratulations!

You have been selected as a scholarship recipient for the Manufacturing Engineering Technology Machinist Certificate Program at Texas State Technical College, Waco, Texas. This scholarship will cover the cost of tuition, books and fees for the next three quarters.

After you have signed up for classes in the MET office, please bring your paperwork to the MAST building.

If you have any questions please don't hesitate to call this office at (817) 867-3526. Once again, Congratulations.

Sincerely,

Joe Penick
Project Director

Machine Tool Advanced Skills Technology Program (MAST)
3801 Campus Dr. Waco, Texas 76705
817/867-3526 FAX: 817/867-3221

Texas State Technical College
Waco

Congratulations to MAST Scholarship Recipients,

You have applied for, and been selected, to participate in a very special program at Texas State Technical College. The program is called **MAST** and it stands for Machine Tool Advanced Skills Technology Program. The **MAST** grant was awarded to TSTC by the U.S. Department of Education. Our goals are (1) to identify national skills standards for several metalworking occupations, (2) to develop curriculum which would provide training to persons interested in pursuing careers in these fields, and (3) to make young people more aware of the career opportunities in the areas of manufacturing and metal working.

The cornerstone of all metalworking occupations is the Machinist. The machinist is the skilled technician who is responsible for the metal molds from which plastic parts are molded. The machinist is the person who builds the tools and dies which are used in manufacturing plants throughout the world. The machinist is the person who performs many of the precision machining operations which are required to produce every conceivable type of product from automobiles to computers to space shuttles. As you can see, the machinist plays a very important role in making America one of the greatest nations of the world. The countries which possess the greatest manufacturing resources also have the capability to produce the greatest wealth.

The duties of the machinist have changed greatly the last 25 years. While the machinist trade was once considered to be a dirty, monotonous job; it has evolved into an highly skilled occupation which requires the use of computers, sophisticated multi-axis computer controlled milling and turning centers, and many other high technology advancements. Where products were once manufactured to tolerances which were measured in thousands of an inch, tolerances within a few millionths of an inch are now common. As you can see, these changes will require a new type of machinist. Not only must he or she be familiar with the conventional metal working machines and tools, but he or she must also be "conversational" with many of the new computer controlled measuring and machining tools which are now commonplace on the shop floor.

Remember that the goals of the **MAST** Program are to identify the required duties and tasks for a machinist in today's workplace, and to develop a curriculum (training program) which will prepare a person to enter that workplace with confidence. All of this sounds wonderful so far; but, the best is yet to come.

This is where you come in. Without you, **MAST** could have been just a lot of talk and a lot of paper. You have been awarded an opportunity to receive training which will equip you to work in virtually any city or in any state where manufacturing operations are performed. Not only have you received a scholarship valued at about $2000.00, but you can expect rewards which are many times greater than the value of the scholarship. You will be learning the same exact skills which industry has told us are the most important for their employees. When you graduate you will be offered many opportunities for employment at starting wages which are much higher than for students who choose not to go school. And the best part is that you will have excellent technical skills which you will be able to market the rest of your working life. The skills which you are about to learn at TSTC will enable you to make enough money to buy that new pickup, or that new home, or begin a family, or anything else that you want to do. The number of young people entering the machinist occupation is far short of the number of machinists which are needed to support American industry. Therefore you can expect many opportunities for advancement and promotion in the years to come. Congratulations!

The MAST staff at TSTC want to welcome you to our campus, and want to help make your entry into college go as smoothly as possible. When you come on to our campus to register, we would like for you to stop by our office first (ITC Building, Room 134). ***Remember that you must have completed your Application for Admission into TSTC prior to registering for classes. Also remember that the dates for Early Registration are August 7-11 and that Regular Registration is September 6, with September 5th being set aside for new student orientation.*** One of our staff will assist you in getting to the right place to register for your classes and then getting to the Business Office to get proper credit for your MAST scholarship. We would like to help insure that the registration process goes as smoothly as possible for you. Once you are registered and are attending classes, please feel free to stop by, or call our office (817) 867-3526 when you have questions relating to life on campus. We may not know all the answers but we will certainly be glad to assist in any way that we can. Once again, congratulations and we thank you for participating in MAST with us.

Yours truly,

Wallace Pelton

Wallace Pelton, Site Coordinator - MAST

The MAST staff at TSTC

Dr. Hugh K. Rogers	Project Director
Joe Penick	Project Coordinator
Terry Sawma	Research Coordinator
Wallace Pelton	Site Coordinator
Rose Mary Timmons	Senior Secretary/Statistician

- STUDENT ASSESSMENT/RESULTS ANALYSIS

1. MAST Consortia Partner College name:
   Texas State Technical College at Waco, TX.

2. Number and category of those enrolled in the program:

Started	Finished	
25	21	84% Completion Rate
24	20	Male
1	1	Female
21	17	White
1	1	Black
2	2	Hispanic
0	0	Asian
0	0	Native American
1	1	Foreign

*Please note that in the following section that some students fell into more than one category.

1	1	Single head of household
2	2	Single parent
0	0	Disability (Physical or Mental)
17	15	Social/Economic Status (gross family income of $22,800 or less)

All students were pre-tested during the first quarter of their enrollment at TSTC. A 50 question multiple choice test was prepared. The test covered general mechanical knowledge and a number of topics which are specific to the machine trades. (A copy of this pre-test, along with a summary of student scores, may be found at the end of this section.) Each student also completed a general mechanical aptitude test at our college counseling center. (A copy of this test, along with a summary of the results, may also be found at the end of this section.) Students were post-tested during the summer of 1996, which was the last quarter of the pilot program. Students were given the same test that was used for pre-testing. Comparisons and analysis were then performed. (A summary of student scores may be found at the end of this section along with a comparison of the pre-test and the post-test results.)

Machine Tool Advanced Skills Technology Program (MAST)

3801 Campus Dr. Waco, Texas 76705
817/867-4849 FAX: 817/867-3380
http://machinetool.tstc.edu/

Texas State Technical College
Waco

NAME:

PRE/POST - TEST for MACHINE TOOL STUDENTS

Directions: Circle the letter beside the best answer for each of the questions below. (2 pts.each)

1. The smallest graduation on a rule with No.4 graduations is:
    - a. .5mm
    - b. 4ths
    - c. 1/64"
    - d. quarters

2. A surface plate:
    - a. is a reference
    - b. measures surface finish
    - c. is made of steel
    - d. has four point suspension

3. There are ____ threads on a spindle of an inch micrometer.
    - a. 25
    - b. 100
    - c. 40
    - d. 15

4. The value of each line on the sleeve or barrel is:
    - a. .100"
    - b. .025"
    - c. .050"
    - d. .001"

5. The value of each line on the thimble is:
    - a. .100"
    - b. .025"
    - c. .050"
    - d. .001"

6. Surface finishes are important to:
    - a. prolong the life of parts
    - b. make products attractive
    - c. speed up production
    - d. lower cost

7. The angle of a center punch should be:
    - a. 90°
    - b. 45°
    - c. 60°
    - d. 30°

8. Dividers are used to:
    a. scribe arcs
    b. scribe circles
    c. transfer measurements
    d. all of the above

9. The most common hammer used by machinists is the:
    a. claw
    b. ball peen
    c. straight peen
    d. cross peen

10. Open-end wrenches are offset about 15° to:
    a. prevent slipping
    b. fit several sizes
    c. get into close places
    d. fit neatly into tool boxes

11. One precaution to observe when using an adjustable wrench is to:
    a. use only on hex nuts
    b. adjust tightly to the nut
    c. use only on square nuts
    d. none of the above

12. The cross-sectional shape of an Allen wrench is:
    a. square
    b. round
    c. hexagonal
    d. rectangular

13. The permissible variation is called the:
    a. tolerance
    b. size
    c. basic dimension
    d. none of the above

14. How far can a 1" diameter piece of stock safely stick out of a lathe chuck unsupported?
    a. 1"
    b. 2"
    c. 3"
    d. 4"

15. The difference between the "reading" of an outside micrometer and a depth micrometer is:
    a. the outside mike is easier
    b. the depth mike is backward
    c. the depth mike reads in .001"
    d. the outside mike reads direct

16. Enlarging a previously drilled hole using a single point cutting tool is called:
    a. counterboring
    b. boring
    c. reaming
    d. countersinking

17. To fit a small tapered shank tool into a large tapered spindle you use:
    a. a drill drift
    b. a tapered sleeve
    c. a drill socket
    d. a #4 morse

18. A plug tap has ___ imperfect threads on it.
    a. 7
    b. 1
    c. 3
    d. 9

19. The tap drill for a 3/8-16-NC thread is:
    a. 5/16"
    b. 3/8"
    c. 17/32"
    d. .299"

20. A hand reamer:
    a. removes 1/32"
    b. leaves the hole smooth
    c. has a tapered shank
    d. all of the above

21. A sine bar is used for:
    a. measuring angles
    b. machining tapers
    c. layout work
    d. all of the above

22. The complimentary angle of 35° is:
    a. 65°
    b. 35°
    c. 90°
    d. 55°

23. The conventional drill point angle is:
    a. 118°
    b. 110°
    c. 90°
    d. 60°

24. The part on the ends of a taper shank drill bit that helps drive it is the:
   - a. tang
   - b. flute
   - c. margin
   - d. driver

25. If a drill bit has unequal lip length, then:
   - a. the hole will be too small
   - b. the hole will be too deep
   - c. the hole will be too big
   - d. the hole will be too shallow

26. What speed is required to drill a 1" hole in aluminum at 300 feet per minute?
   - a. 400 RPM
   - b. 800 RPM
   - c. 1200 RPM
   - d. 1600 RPM

27. What speed is required to drill a 1" hole in mild steel at 100 feet per minute?
   - a. 100 RPM
   - b. 200 RPM
   - c. 300 RPM
   - d. 400 RPM

28. The note T.I.R. on a drawing means:
   - a. The internal radius
   - b. Total indicated run-out
   - c. Test in reverse
   - d. Texas Industrial Requirements

29. To produce a hole suitable for a socket head cap screw to fit in flush is called:
   - a. treepanning
   - b. counterboring
   - c. drilling out
   - d. none of the above

30. What hand tool is used to cut an external thread?
   - a. a threading file
   - b. a threading tap
   - c. a threading die
   - d. a threading arbor

31. The smallest graduation on a metric rule is:
   - a. 1mm
   - b. .5mm
   - c. .25mm
   - d. 1cm

32. To change speeds on a variable speed lathe or mill, the spindle must be:
    a. completely stopped
    b. in neutral
    c. turning
    d. none of the above

33. The half-nut lever on a lathe is:
    a. used for facing
    b. used for turning
    c. used for threading
    d. used for reversing the feed direction

34. As a rule carbide cutting tools can be run ____ than high speed cutting tools.
    a. faster
    b. slower
    c. more aggressively
    d. less aggressively

35. Feed on a drill press is based on:
    a. inches per minute
    b. inches per revolution of the spindle
    c. inches per foot
    d. none of the above

36. When lathe centers are out of line on a lathe, the resulting work will be:
    a. straight
    b. wavy
    c. hopeless
    d. tapered

37. A dial indicator is used for:
    a. alignment of work holding devices
    b. alignment of workpieces
    c. inspection of work in progress
    d. all of the above

38. Knurling is used to:
    a. improve appearance
    b. provide a good gripping surface
    c. increase size for press fits
    d. all of the above

39. Holes to be drilled are "spotted" with a:
    a. center finder
    b. center drill
    c. combination square and scribe
    d. a magnifying glass

40. A shear pin is:
   a. for punching 1/4" holes
   b. a safety device
   c. hardened for strength
   d. none of the above

41. When should safety glasses be worn in the shop?
   a. when the light is poor
   b. when you are working on extremely precision parts
   c. at all times
   d. when you are working on hazardous materials

42. Which tools should not be mounted in a drilling chuck?
   a. a drill bit
   b. an end mill
   c. a tap
   d. a reamer

43. Drill bits are sized under four common systems: fractional, number, metric, and ___.
   a. oversize
   b. undersize
   c. letter
   d. ultra-precision

44. The letters CNC stand for:
   a. computerized nitride coating
   b. calculated numbering center
   c. computer numerical control
   d. cut no corners

45. A sheet metal brake is used for:
   a. stamping sheet metal
   b. cutting sheet metal
   c. stopping metal from moving in an emergency
   d. bending sheet metal

46. Surface grinders are use for:
   a. producing precision flat surfaces
   b. producing precision parallel surfaces
   c. producing precision right angle surfaces
   d. all of the above

47. Computer controlled machines are usually used:
   a. for production work
   b. for prototype work
   c. for precision work
   d. all of the above

48. The “Bridgeport” type machine is:
    a. a horizontal milling machine
    b. a vertical milling machine
    c. a jig bore machine
    d. a drill press

49. Which lathe workholding device is the best to use for holding round stock?
    a. a 3-jaw chuck
    b. a 4-jaw chuck
    c. a faceplate
    d. a collet chuck

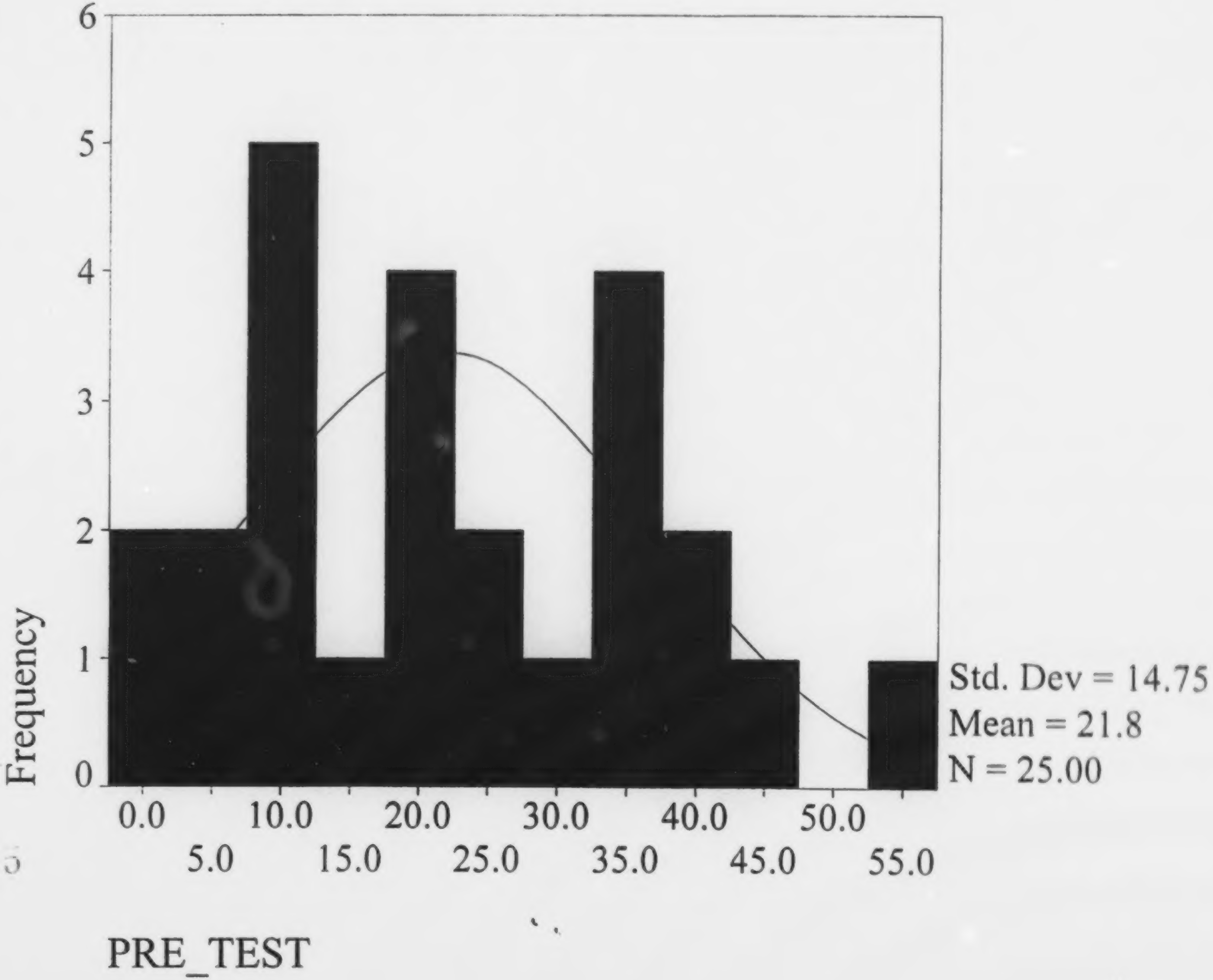
50. Always ____ a machine before measuring, cleaning or making adjustments.
    a. oil
    b. slow down
    c. stop
    d. none of the above

Frequence Distribution of Pre-Test

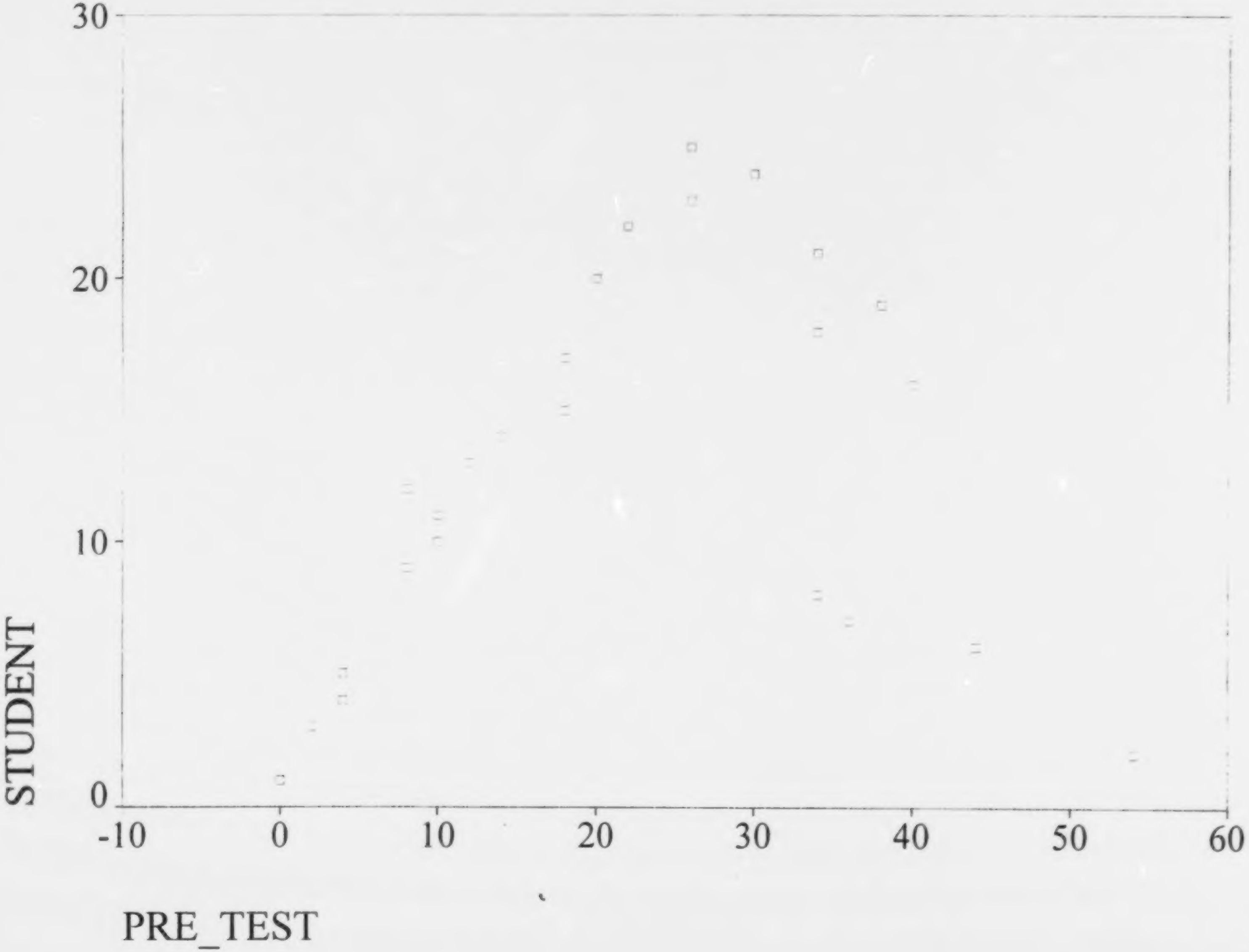
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**0**	1	4.0	4.0	4.0
	2	1	4.0	4.0	8.0
	4	2	8.0	8.0	16.0
	8	2	8.0	8.0	24.0
	10	2	8.0	8.0	32.0
	12	1	4.0	4.0	36.0
	14	1	4.0	4.0	40.0
	18	2	8.0	8.0	48.0
	20	1	4.0	4.0	52.0
	22	1	4.0	4.0	56.0
	26	2	8.0	8.0	64.0
	30	1	4.0	4.0	68.0
	34	3	12.0	12.0	80.0
	36	1	4.0	4.0	84.0
	38	1	4.0	4.0	88.0
	40	1	4.0	4.0	92.0
	44	1	4.0	4.0	96.0
	54	1	4.0	4.0	100.0
	Total	25	100.0	100.0	
Total		25	100.0		

Statistics

	N						Std.										Percentiles		
	Valid	Missing	Mean		Median	Mode	Deviation	Variance	Skewness		Kurtosis		Range	Minimum	Maximum	Sum	25.00	50.00	75.00
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
PRE_TEST	25	0	21.84	2.95	20.00	34	14.75	217.64	.332	.464	-.805	.902	54	0	54	546	9.00	20.00	34.00


6
5
4
3
2
1
0
Frequency
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
Std. Dev = 14.75
Mean = 21.8
N = 25.00
PRE_TEST

Scatterplot of Pre-Test Results



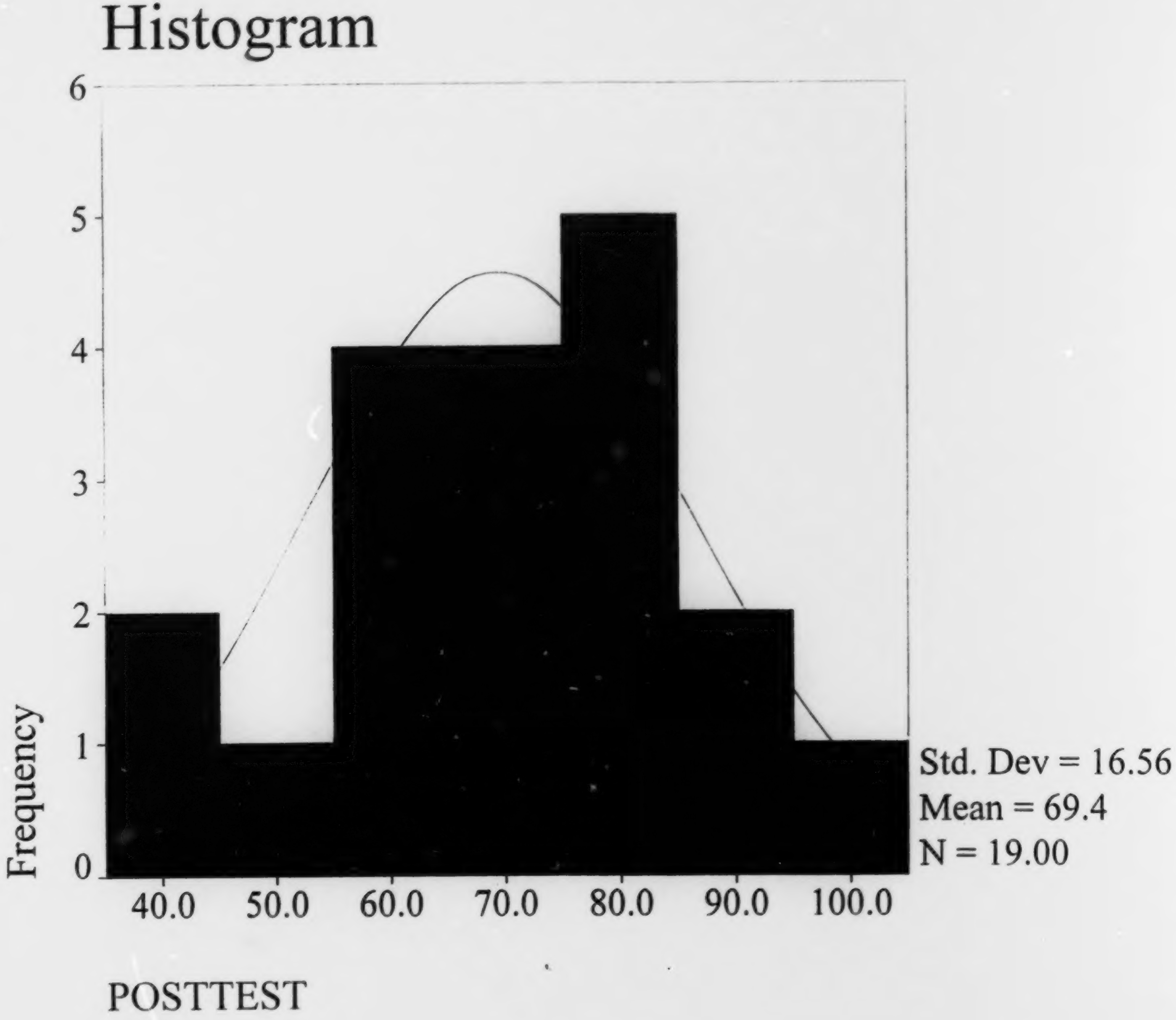
Frequence Distribution of Post-Test

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	36	1	4.0	5.3	5.3
	44	1	4.0	5.3	10.5
	46	1	4.0	5.3	15.8
	56	1	4.0	5.3	21.1
	58	1	4.0	5.3	26.3
	60	1	4.0	5.3	31.6
	62	1	4.0	5.3	36.8
	66	2	8.0	10.5	47.4
	72	1	4.0	5.3	52.6
	74	1	4.0	5.3	57.9
	78	1	4.0	5.3	63.2
	80	1	4.0	5.3	68.4
	82	2	8.0	10.5	78.9
	84	1	4.0	5.3	84.2
	86	1	4.0	5.3	89.5
	90	1	4.0	5.3	94.7
	96	1	4.0	5.3	100.0
	Total	19	76.0	100.0	
Missing	System Missing	6	24.0		
	Total	6	24.0		
Total		25	100.0		

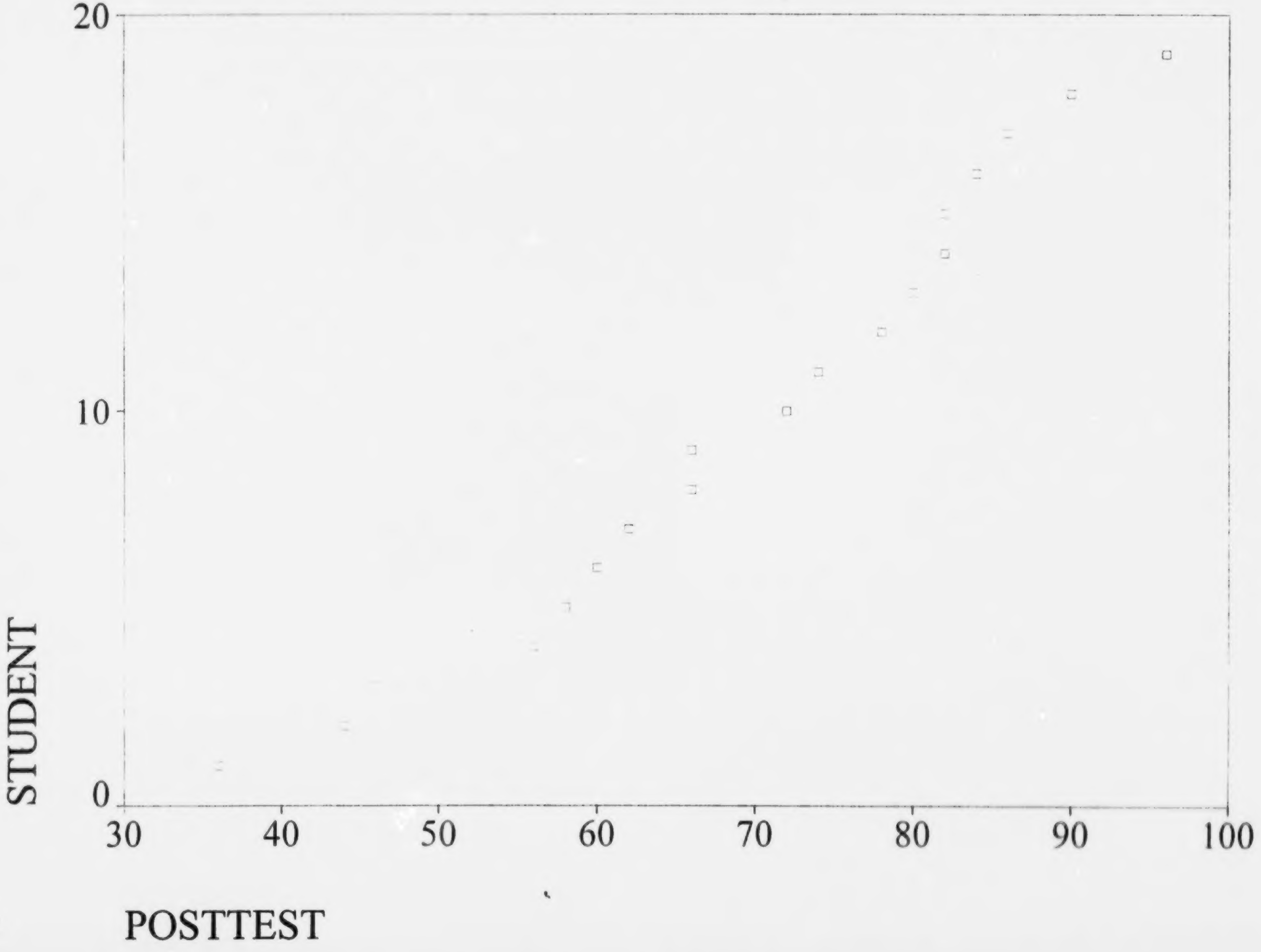
Statistics

	N		Mean		Median	Mode	Std. Deviation	Variance	Skewness		Kurtosis		Range	Minimum	Maximum	Percentiles		
	Valid	Missing														25.00	50.00	75.00
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
POSTTEST	19	6	69.37	3.80	72.00	66[a]	16.56	274.25	-.410	.524	-.593	1.014	60	36	96	58.00	72.00	82.00

a. Multiple modes exist. The smallest value is shown


Histogram
6
5
4
3
2
1
0
Frequency
40.0
50.0
60.0
70.0
80.0
90.0
100.0
POSTTEST
Std. Dev = 16.56
Mean = 69.4
N = 19.00

Scatterplot of Post-Test Results



For more information:

MAST Program Director
Texas State Technical College
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Waco, TX 76705

(817) 867-4849
FAX (817) 867-3380
1-800-792-8784
http://machinetool.tstc.edu